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Developing a framework to facilitate the assessment of asset management information quality in facilities management operations

Developing a Framework to Facilitate the Assessment of Asset Management Information Quality in Facilities Management Operations

By

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Abstract

Information quality issues have taken an increased importance in academia and industry and have many causes attributed to it. Poor information quality presents significant costs to an organisation, financially and non-financially. However, the issue of information quality has not been explored in depth in the field of facilities management. Thus, within the context of facilities management, this has led to failures in asset management programs undertaken by facilities management organisations and present a significant challenge in the decision-making process by facility managers. Achieving improved asset information quality in facility management operations is thus of immense importance to stakeholders in facilities management. To this end, various methods and frameworks have been developed to assess and improve information quality, but these have very limited scope and not applicable in facilities management organisation undertaking asset management. To this end, this research aims to evaluate the quality of information and determine what factors impact information quality of asset management programs in the facilities management domain. The research adopts an exploratory mixed-method methodology, which allows data to be collected and analysed using qualitative and quantitative techniques to provide greater insight of the phenomenon in facility management operations. The qualitative approach uses thematic analysis to determine what factors affect the quality of information from the information, organisation, and people domain respectively. The results from this analysis show that factors affecting information quality of asset management programs is multidimensional. In addition, 71 information quality attributes has been identified from the qualitative analysis. In the quantitative phase, principal component analysis (PCA) with direct oblimin rotation, ANOVA, and measure of central tendency (MCT) techniques were adopted to identify the specific dimensions of information quality in asset management, the effect of the structure of the organisation on information quality, and the prevalence of information quality issue in asset management respectively. The results from the analysis identified 12 information quality dimensions which was grouped into seven (7) categories. Also a high prevalence of information quality issue experienced by facilities management professionals was observed with a mean value of 7.90 and median value of 8.00 and standard deviation of 1.467 which was normally distributed. Further analysis indicated that the hierarchical structure of the organisation had an effect on information quality which was statistically significant. Based on the result of the analysis, a framework, using a perceptual map premised on multi-dimensional scale (MDS) technique, has been developed that seeks to assess the quality of information of asset management programs in facilities management.

Key Words: Facilities Management, Asset Management, Information Quality, Mixed Method Methodology, Principal Component Analysis, ANOVA, Perceptual Map

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List of Abbreviations

AFM: Association of Facilities Management

AIMQ: AIM Quality Methodology

AM: Asset Management

ANOVA: Analysis of Variance

AOP: Annual Operating Plan

BE: Built Environment

BIFM: British Institute of Facilities Management

CAFM: Computer Aided Facilities Management

CCL: Climate Change Levy

CIFM: Computer Integrated Facilities Management

CMMS: Computerised Maintenance Management Software

DPA: Data Protection Act

ER: Entity Relationship

ERP: Enterprise Resource Planning

EuroFM: European Facility Management Network

FinMgt: Financial Management

FM: Facilities Management

FMA: Facilities Management Association

FMI: Facilities Management Institute

FMS: Facilities Management Software

GDP: Gross Domestic Product

HRBS: Hierarchical Risk Breakdown Structure

HSE: Health and Safety Executive

IAM: Integrated Asset Management

IFM: Institute of Facilities Management

IFMA: International Facilities Management Association

IntFM: Integrated Facilities Management

IP: Information Product
IQ: Information Quality
IQ grid: Information Quality Grid
IQA: Information Quality Assessment
IQAF: Information Quality Assessment Framework
IQGA: Information Quality Gap Analysis
IQM-CMM: Information Quality Management Capability Maturity Model
IT: Information Technology
IWMS: Integrated Workplace Management System
KMO: Kaiser-Meyer-Olkin
KPI: Key Performance Indicators
LCCA: Life-Cycle Cost Analysis
LCM: Life Cycle Management
NFMA: National Facilities Management Association
PCA: Principal Component Analysis
PDA: Personal Digital Assistant
PerMap: Perceptual Map
PFI: Private Finance Initiative
PSP/IQ: Product Service Performance/Information Quality
RM: Risk Management
SERVQUAL: Service Quality
SLA: Service Level Agreement
TFM: Total Facilities Management
TIFM: Total Integrated Facilities Management
TIQM: Total Information Quality Management
TQM: Total Quality Management
USA: United State of America
WRR: Weekly Risk Report

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"…If I have seen further, it is by standing on the shoulders of giants…"

[Sir. Isaac Newton 1676]

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I dedicate this PhD to my Father and Mother Mr and Mrs E.A. Essiet

Chapter 1 Introduction

Economic flux has created a situation where organisations seek efficiency gains due to constrained budgets and competing priorities (Ottoman, Nixon, & Lofgren, 1999). This has led to the exponential rise of intermediaries known as facilities management (FM) organisations, whose responsibility is to manage the non-core operations of organisations, thus allowing such organisation to focus on its core objectives (Alexander, 2004). Facilities management (FM) organisation are primarily known for maintenance within the built environment (BE). However, this view has been challenged and gradually blurred with the emergence of total or integrated facilities management (TFM, IntFM) (Bungar, 2012). Ikediashi & Okwuashi, (2015) further adds that FM has strongly established itself within the property and construction industry domain on account of orientation as a strategy that provides high quality, cost-effective and integrated approach to management of facilities and its related services. This approach adopts asset management (AM) as its strategic focus to help minimise cost, reduce risk, and improve performance (Rondeau, Brown, & Lapides, 2006). Despite the adoption of asset management, there are peculiar challenges experienced in FM. For instance Price, Dobson, & Pakgohar, (2016) highlighted problems with service excellence contingent on the following factors; contract scope, contract complexity, human resource, and material resource. In addition to this, there is the need for appropriate decision support systems to managing choice and flexibility in delivering FM services (Ikediashi & Okwuashi, 2015). However, Ikediashi & Okwuashi, (2015) argues that decision makers are increasingly facing issues in the absence of sufficient and reliable information to make decision about of FM services. Lavy, Garcia, & Dixit, (2014) presents challenges relating to performance in FM. To this end, the authors argue the significance in identifying a set of KPIs to establish effective performance evaluation metrics in FM, but further notes that a large number of KPI adds a level of complexity with a narrow perspective, thus lacking quantification and applicability across a range of projects. An underlying factor contributing to these challenges in FM is the quality of information used during the operations.

Poor information quality (IQ) has led to the rise in the cost of facilities management service provision (Koronios, Lin, & Jing, 2005; Vanier, 2001). as a result of this, facilities information systems i.e. records, documents, and databases are not frequently up-to-date thus a complete history of changes are seldom available for supporting decision-making (Akcamete, 2011). This has resulted in the loss of abilities for facilities management to sustain contracts and service provision with significant loss of revenue and jobs as implied by Jylhä & Suvanto, (2015).

It has been observed that literature, societies, and groups have suggested various strategies to improve facilities management but rather with a focus on the maintenance facet of its operations (Dibley, 2011; Lucas, 2012; Paz & Viriyavadhana, 1995; Sabol, 2008; Shen, Hao, & Xue, 2012). Such efforts tend to examine, albeit narrowly, the interactions, synergies, and influences these have on facilities management (FM) operations with very limited effect. Thus, there is recognition by FM organisations of the need to improve the performance of the overall operating process through a different approach (Amaratunga & Baldry, 2003; Amaratunga, Baldry, & Sarshar, 2000; Too, 2010b). This thesis sets out to present an alternative paradigm to FM research with a focus on information quality (IQ).

This chapter presents the overall thrust of this research. Section 1.1 examines its scope and justification and introduces the research problem. Section 1.2 presens the gap within the available literature, the research aim, questions, and objectives. A discussion on methodology is provided in section 1.3. The conceptual framework follows this and its justification presented in Section 1.4. Section 1.5 provides the contributions made to existing body of knowledge and practice. Finally, Section 1.6 presents the structure of the thesis.

1.1 Research Scope and Justification

The preceding section highlighted that asset management (AM) has been adopted as a strategic focus to minimise cost, reduce risk, and improve the performance of facilities management (FM) service. However, the issue of poor information quality (IQ) and its effect on facilities management (FM) has affected revenue, jobs, and the ability to improve overall performance. Thus, this study examines the causes of poor information quality (IQ) affecting asset management (AM) programs in facilities management (FM) services. This study argues that information quality (IQ) influence the nature of the operations and the performance of facilities management (FM) through asset management (AM). It also argues that for FM to add value the issues of asset management (AM) information quality (IQ) is to be taken seriously. To this end, this study will investigate the issues affecting IQ on AM programs in FM from the perspectives information management, organisation structure and processes, and people. The succeeding section will present the concepts investigated in the research.

1.1.1 Facilities Management

This section introduces the first concept of facilities management (FM). The field of FM is a relatively young sector in the United Kingdom (UK) when compared with other industries such as manufacturing, aerospace, finance. It includes a broad spectrum of activities delivering a full range of hard services i.e. building maintenance, to soft services i.e. security and cleaning (Bungar, 2012). Reports from BIFM, (2009) noted the sector in the United Kingdom (UK) was worth between £40billion and £95billion per annum but according to Bungar, (2012), the United Kingdom's potential market for FM services between the years 2007 and 2011 was valued between £115billilon and £120billion. This marks a huge contrast in the total estimated value of the industry. Thus, there is a significant challenge in determining the actual value of the service it provides to the built environment (BE) as well as introducing significant opportunities.

According to BIFM, (2009), FM has been defined as the integration of processes within an organisation to maintain and develop the agreed services which support and improves the effectiveness of the primary activities. An integral aspect of FM is to provide a sustainable environment which is considered safe and efficient through the management of non-core activities and resources (R. E. Brown & Humphrey, 2005). In essence, FM objectives are to add value to an organisation operation through efficient management of non-core activities. The value adding activity of FM is a unique function that requires a myriad of complex planning activities involving various skills, practices, systems, and processes with the sole purpose of adding value to the business operations.

Nutt & McLennan, (2002) provides an alternative definition to FM as the management of facilities resources and services in support of the activities of an organisation. This supporting role of FM is considered as the most significant factor that distinguishes it from other services (Nutt & McLennan, 2002). According to Nutt & McLennan, (2002) the supporting role of FM impacts the financial remit of facility investment, asset value, and operational cost as well as the human and physical concerns. To this end Nutt & McLennan, (2002) identified generic resources that are central to FM function; (1) business resources, (2) people resources and (3) knowledge resources. These resources further have an impact on the strategies developed by FM to manage risks and maximise opportunity.

Rondeau et al., (2006) describes FM as a multidisciplinary concept that ensures functionality of the built environment (BE) by taking the perspective of coordinating and integrating people, place, process, and technology (Rondeau et al., 2006). Figure 1:1 presents an illustration of the conceptual approach to FM.

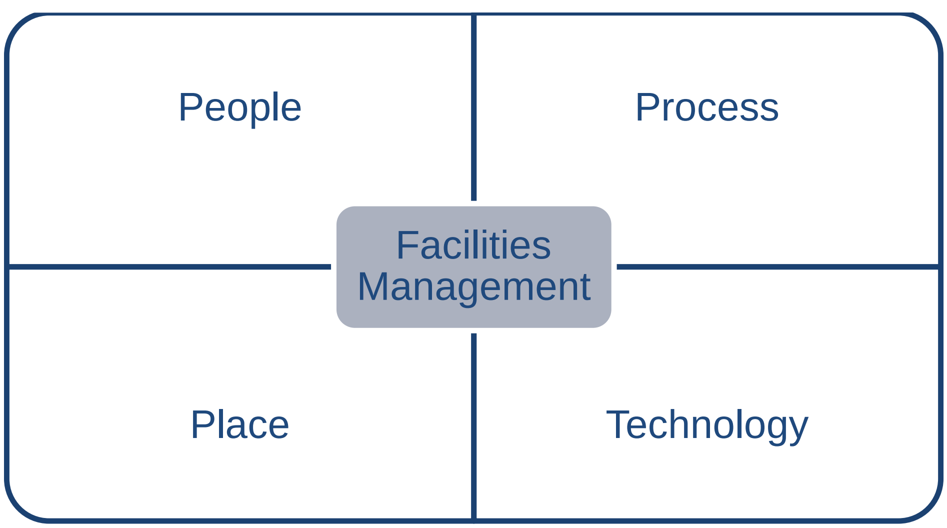


Figure 1:1 FM Concept

Rondeau et al., (2006) go further to argue that FM's mission is to provide high-quality, cost-effective service to in-house customers in support of the corporate business plan. Alexander, (2004) takes an alternative view and posits FM to be a strategically integrated methodology to maintaining, improving, and adapting the building, and support services of an organisation to create an environment that supports the primary objective of the organisation. As argued by Alexander, (2004) this approach should embrace strategically oriented continuous improvement to attain high levels of effectiveness.

Further examination of FM has resulted in the segmentation of objectives of FM on two levels; (1) the local level, and (2) the national level (Nutt & McLennan, 2002). At the local level, the objective of FM is the efficient management of facility resources and services to provide support to organisations, their operations, their working groups, project teams, and individuals (Nutt & McLennan, 2002). At the national level, the strategic objective of FM is to provide appropriate infrastructure and logistic support to business and public endeavour (Nutt & McLennan, 2002). Based on these statements Nutt & McLennan, (2002) posited that the primary function of FM is resource management at both strategic and operations levels of support.

According to Nutt & McLennan, (2002), the strategic approach adopted by FM is directed at the management of uncertainty over time with the awareness of the fact that the level of uncertainty increases with time. Thus decision makers in FM rely on trends and forecast over the medium term i.e. 2-5 years, in their decision-making actions because the level of uncertainty increases exponentially in the long term i.e. 5-10 years (Nutt & McLennan, 2002). Nutt & McLennan, (2002) also acknowledge that managing uncertainty during this period is not easy, as this requires significant levels of quality information. This further affects the actions of FM and leads to two outcomes as suggested by Nutt & McLennan, (2002); (1) a negative outcome [close down risk: avoid failure], and (2) a positive outcome [open up opportunities: achieve success]. According to Nutt & McLennan, (2002), the first outcome focuses on measures to contain, reduce, transfer, and avoid risk while the second seeks to maintain and generate opportunities and advantage, both planned and random, that facilities might provide (Figure 1:2).

Therefore, for FM to be effective, its operations processes must be effectively coordinated to ensure information supporting decision making is reliable and adequate to influence the core activities of the organisation it supports and reduce risk significantly while making the most of opportunities identified.

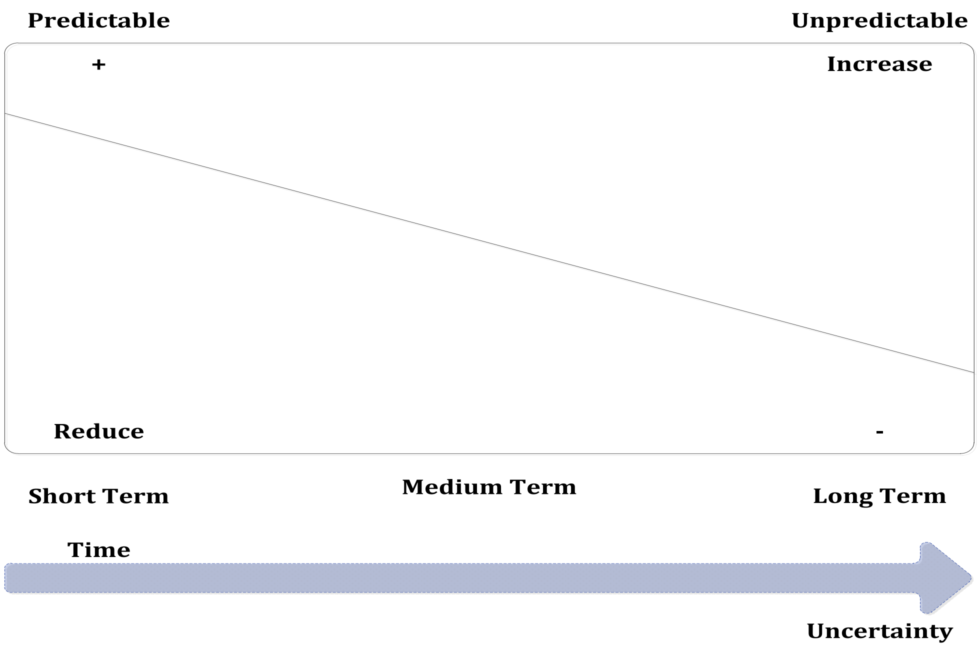


Figure 1:2 Planning Timeframe in FM Decision-Making

1.1.2 Asset Management

This section introduces the next concept asset management relevant to this research. A relevant aspect to FM is asset management (AM). Asset management (AM) is considered a strategic discipline that adds value to an operations physical and non-physical assets (Rondeau et al., 2006). With specific reference to the built environment (BE), asset management (AM) refers to the administration of the plant and equipment during its whole life (S. Lin, Gao, & Koronios, 2006). Lin et al., (2006) further added that asset management (AM) is a structured program to optimise the life-cycle value of the property by reducing the cost of ownership while providing the required level of service. It seeks to (1) reduce risk associated with managing assets, (2) minimise cost related to managing the asset, (3) improve the performance of operations involved in managing assets, and (4) assess life cycles of an asset to effectively maximise the value of assets

(The IAM, 2008). Laue, Brown, Scherrer, & Keast, (2014) supports the view of Lin et al., (2006) and posits that AM is the process of organising, planning, and controlling the acquisition, care, refurbishment, and disposal of infrastructure assets. This process is systematic and structured covering the whole life of the asset (Laue et al., 2014).

According to Rondeau et al., (2006), AM is a function that resides within FM which informs the strategic administration, operation, and management of real property portfolio controlled by an owner. Nutt & McLennan, (2002) alluded to the fact that a major function of FM is the reduction of risk and the maximisation of opportunity over the life cycle of an operation. Achieving this requires a redirection away from traditional capital investment practices to a management regime that gives the highest priority in ensuring the long-term viability of a facility (Nutt & McLennan, 2002). It also ensures that scarce capital resources are properly allocated and managed to maximise the return on investment. It requires balancing cost, risk, performance, and lifecycle management. To this end, Nutt & McLennan, (2002) advocated the adoption and implementation of integrated asset management (IAM) throughout the organisation. Integrated asset management (IAM) represents the sustained best mix of asset care and asset exploitation (Woodhouse, 2007).

As defined by Nutt & McLennan, (2002) IAM is the sum of all activities that result in appropriate infrastructure for the cost efficient delivery of service. IAM is a concept which organisations use to optimise and integrate the number, size, type, location, initial capital cost and on-going maintenance expenses of facilities (Nutt & McLennan, 2002). Integrated asset management (IAM) takes the position of a long-term view and is a tool to match resource planning and investment with corporate service delivery (Laue et al., 2014; Nutt & McLennan, 2002; TheIAM, 2012). Laue et al., (2014) argues that IAM should address the operational and strategic management of asset by taking into account the overall organisational management, information management, and human factors.

A strong argument for the adoption of IAM is the changing macroeconomic environment. The macroeconomic environment is perceived as having a great impact on organisation behaviour thereby forcing the organisation to adopt innovative and integrated approaches to planning and decision making (AMA Research Ltd, 2004; Interserve, 2013; MTW Research, 2014; Nutt & McLennan, 2002). This change can be examined using the political, economic, social, technological, legal, and environmental (PESTLE) framework (Figure 1:3) (MTW Research, 2014; Pearce & Robinson, 2005).

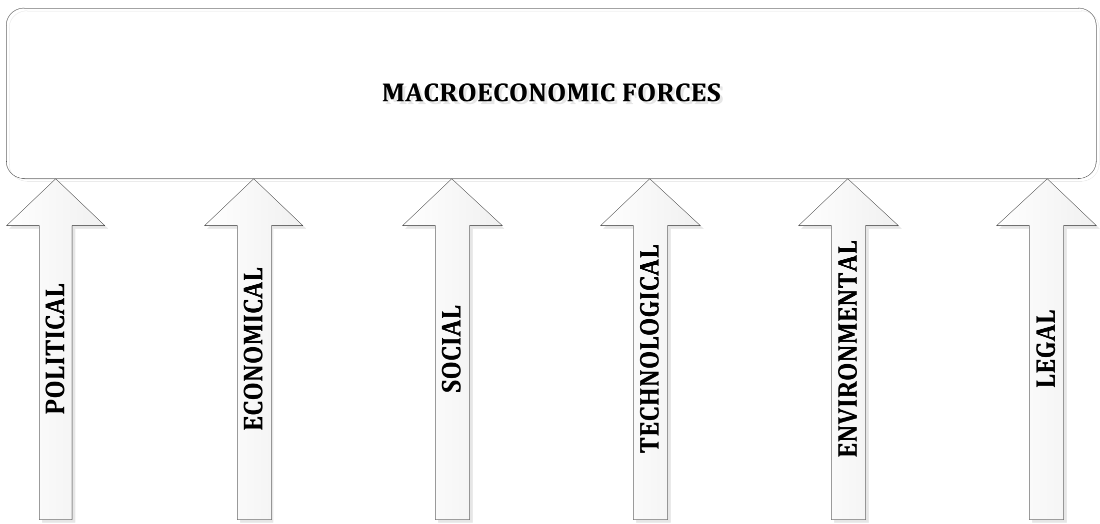


Figure 1:3 Examining macroeconomic forces using PESTLE

Political changes in the United Kingdom has witnessed a remarkable shift in governance (TEWV NHS Foundation Trust, 2014). As a result, greater policy scrutiny is carried out in government with particular reference to fiscal and monetary decisions (Finley, 2012). These decisions further have an effect in the economic situation of the country where government and firm spending are affected in diverse ways thus affecting the gross domestic product (GDP) of the economy (Perman & Scouller, 2004). The social pillar examines the social construct of the economy where it may be deduced that the changes in balance or circumstances on individual lives may affect FM. Rapid changes and development are emanating from the technological sphere. The UK economy has witnessed a rapid shift in the use and adoption of technology, within and without the firm. Smartphones, tablets, and micro portable devices are making inroads into the enterprise and are forcing a change in work patterns (FM World, 2013). Environmental factors have been a major change factor to FM operations. The major concern here is the issue of environmental sustainability with specific reference to carbon emission, energy management and waste management (FM World, 2015b). Changing laws and regulations e.g. health and safety law, employment law, and contract law mean that FM organisation need to be flexible and risk aware to adapt to such changes (FM World, 2015a; Perry, 2009; Perry, Poidevin, & Wustemann, 2009). All this coupled together creates an urgency within FM industry to adopt a robust strategy to cope with the ever-changing environment, manage cost, mitigate risk, improve performance, and handle the life cycle of operations efficiently, hence the development of AM.

The Institute of Asset Management (TheIAM, 2012) has developed a methodology known as PAS55 to support organisation involved in asset or infrastructure management to cope with the changes in the macro environment (Figure 1:4).

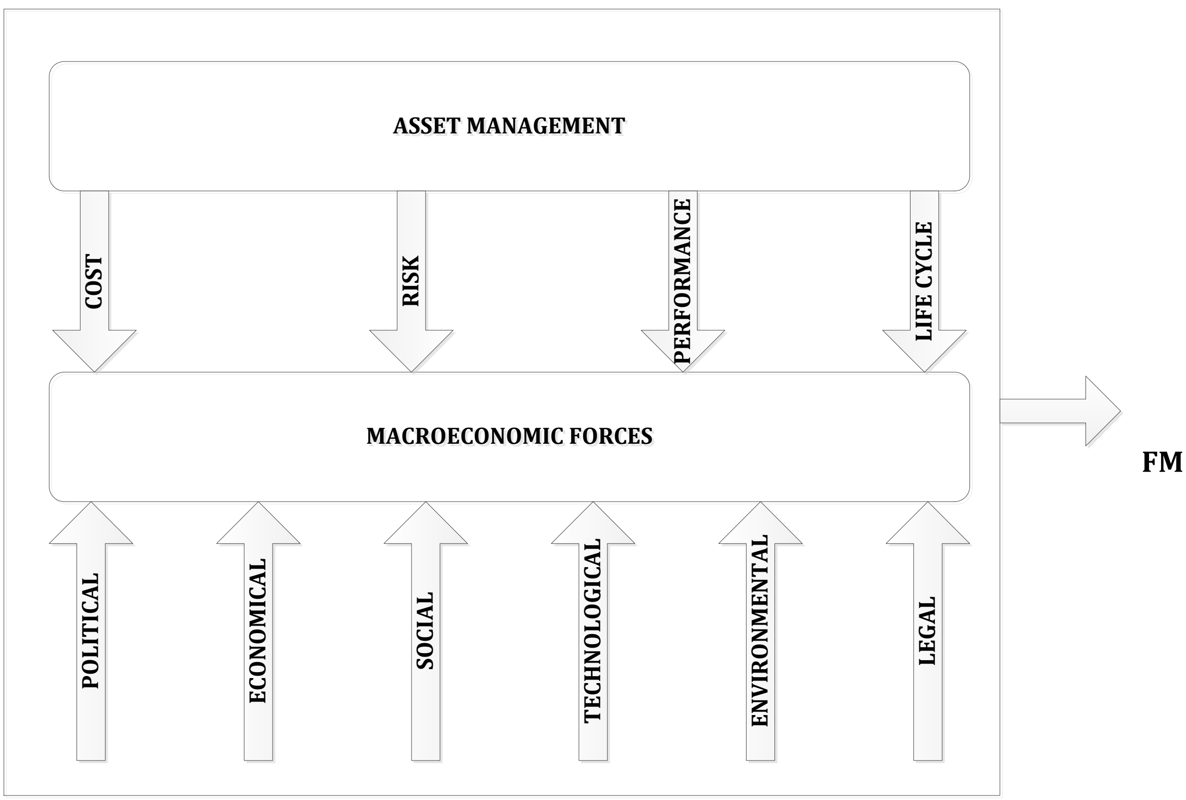


Figure 1:4 Aligning Organisation within the Macro-Environment via Asset Management

TheIAM, (2012) uses the term AM as opposed to IAM. TheIAM, (2012) thereby defines AM as “the coordinated set of activities of an organisation to realise value from asset”.

This definition is similar in meaning to that opined by Nutt & McLennan, (2002). Therefore it may be concluded that IAM (Nutt & McLennan, 2002) and AM (TheIAM, 2012) are one and the same. This research will adopt the definition of AM in the context of TheIAM, (2012) for simplicity.

1.1.3 Information Quality

The third concept introduced in this research is information quality (IQ). As seen from the preceding sections the quality of information plays a significant role in the decision-making process of AM. This in-turn affects the outcomes of FM. Lin et al., (2006) argued that AM is an information-intensive activity. According to Lin et al., (2006) the process of AM is sophisticated because it requires substantial information to be collected from many different parts of the organisation. Thus, the effectiveness of AM is dependent on the quality of information used, which forms the foundation for effective planning, strategy development, and decision-making.

To understand this concept and it effect on AM, it is important to refer to the theory of information. Information theory is concerned with the reproduction of source information and minimising the probability of error or unwanted transformation during the transmission process (Grenn, Sarkani, & Mazzuchi, 2014). This definition is based on the seminal work of SHANNON, (1948). SHANNON, (1948) argued that the fundamental problem of information transmission is that of reproducing at one point either exactly or approximately a message selected at another point. Based on this argument, information theory permits the transmission of information with zero probability of error (Grenn et al., 2014). This error refers to the uncertainty within the transmission system (SHANNON, 1948). Subject to these postulations, IQ constitutes particular attributes that ensure the transmission of information between two parties is relevant to the operation and minimises uncertainty.

The quality of information influences the decision-making outcomes of FM managers undertaking AM thereby influencing planning and strategy of the operations. As reported in a series of interviews by TheIAM, (2013) AM activities generate a significant volume of information. However, such large volume of information inhibits organisations in turning them into actionable knowledge (TheIAM, 2013). Information is obtained, processed, and distributed in AM programs throughout FM operations (S. Lin, Gao, Koronios, & Chanana, 2007). The quality of such information is dependent on and influenced by the technology infrastructure; the organisation's process, policies and procedures; and the skills, knowledge, experience and motivation of the people operating within the organisation (S. Lin et al., 2007). Also, the quality of information has been argued to be influenced by the size of the organisation (Mintzberg, 1979; WILLMER, 1977). Collectively this constitutes the scope of this research.

1.2 Research Gap

UK FM industry is witnessing a surge in information technology (IT) investment thus growing at an exponential rate (AMA Research Ltd, 2004; Bungar, 2012; MTW Research, 2014; WRAP, 2011). However, there is little empirical evidence to suggest that such investment contributes to the productivity and improvements in FM operations and IQ. As an addition, it may be hypothesised that the extensive proliferation of technology is doing more harm than good concerning productivity and IQ, which ultimately influence the people resource in FM operations.

The quality of information concerning AM has been researched in context of heavy infrastructure industry in Australia (Koronios et al., 2005; S. Lin et al., 2006, 2007), and in other service and educations institutions in the United State of America (USA) (Kahn & Strong, 1998; Kahn, Strong, & Wang, 2002; Wand & Wang, 1996). However, there is limited research conducted in the field of FM with reference to AM in the UK. The lack of studies in this area may be attributed to factors such as: (1) the difficulty in measuring such an abstract concept, (2) the inability of managers to see beyond current instituted key performance indicators (KPI), and (3) a general lack of knowledge in IQ management (Eppler, 2001; Hostettler & Delez, 2006; Woodall, Parlikad, & Lebrun, 2012). IQ research has often been conducted from the point of view of databases and information systems (Batini, Cappiello, Francalanci, & Maurino, 2009; Batini & Scannapieco, 2006; Harte-Hanks Trillium Software, 2011; Pipino, Lee, & Wang, 2002;

Sebastian-Coleman, 2013; R.Y. Wang, Storey, & Firth, 1995). These studies approach the issue of IQ from a technical perspective which inadvertently focuses primarily on data (R. J. Price & Shanks, 2005). However, in the context of any operation, data is meaningless unless transformed to information. This transformation process attributes the concept of meaning to the data, which is constructed by the social actors within any operation. The transformation process, in turn, is facilitated by the systems and process implemented within the operation context. From this information is a complex construct having a multi-dimensional perspective i.e. systems, processes, social actors, and operational context. All these influence IQ. However, there is limited research that investigates these concepts and its effect on IQ.

The evidence presented above, therefore, presents a gap in research with specific reference to the FM industry. This research will aim to fill this gap and provide relevant empirical evidence to the causes of poor IQ of AM activities in FM services. The following sections present the aim, questions, and objectives this research seeks to fulfil.

1.2.1 Research Aim

The aim of the research it to develop a framework to enable the assessment of the quality of information used in asset management programs.

1.2.2 Research Questions

The following questions are put forward:

1. How prevalent is the issue of information quality (IQ) in the (FM) industry?
2. Which IQ dimensions are significant for effective AM activities?
3. How can the quality of asset information be assessed in FM operations?

1.2.3 Research Objectives

The following objectives have been formulated to enable the research answer the questions put forward:

1. To examine what factors influence asset management (AM) information quality (IQ) in facilities management (FM)
2. To determine the prevalence of information quality (IQ) issue and influence of organisation structure and size on information quality (IQ) in facilities management (FM) industry
3. To identify the information quality (IQ) attributes specific to asset management (AM) in facilities management (FM)
4. To classify the information quality (IQ) attributes into specific information quality (IQ) dimensions within the context of asset management (AM) in facilities management (FM)
5. Develop and evaluate a framework to improve information quality (IQ) of asset management (AM) activities in facilities management (FM) through expert groups

1.3 Research Methodology

This section outlines briefly the research methodology that will be utilised to achieve the aim of the research. The objective of the study seeks to identify, classify, examine, and evaluate factors that affect the quality of asset information. Therefore, two methods; (1) Qualitative, and (2) Quantitative, will be applied in order to achieve the objectives of this research. This approach is referred to as exploratory sequential mixed method, which involves integrating qualitative and quantitative data in the research study (Bryman, 2008; Creswell, 2014). The overarching methodology for this study is inductive mixed methodology. This is an approach to inquiry involving collecting both quantitative and qualitative data (Creswell, 2014). This aims to guide the process of inquiry through gathering extensive insight into the research questions thereby moving from specific observations to broader generalizations (Burney & Saleem, 2008) which is predominantly inductive as it seeks to develop theory from the observed phenomenon (Schutt, 2012).

To accomplish the research aim, a matrix has been developed as a guide to meeting the objectives systematically (Table 1:1). The matrix consist of the research questions (RQ) and research objectives (RO). Within the matrix, the particular approach and procedure adopted to satisfy each objective and question is outlined. The research methodology (Chapter 3) has been considered in this research as the strategy by which the research is mapped out to find the appropriate solution(s) to the outlined problem (Buckley, Buckley, & H. Chiang, 1976). Buckley et al., (1976) stated that research strategy refers to the nature of the data or process of obtaining the data and the way the researcher goes about generating or testing theory.

Table 1:1 Research Approach Matrix

		RESEARCH OBJECTIVES (RO)				
		RO1	RO2	RO3	RO4	RO5
		Approach and Procedure				
RESEARCH QUESTIONS (RQ)	RQ1	1. Literature Review 2. Qualitative Analysis [Thematic]	1. Quantitative Analysis [Descriptive and Parametric Statistics - ANOVA]			
	RQ2			1. Literature Review 2. Qualitative Analysis [Thematic]	1. Quantitative Analysis [Principal Component Analysis]	
	RQ3					1. Expert Opinion Survey

Methodology determines how a particular piece of research should be undertaken and could be understood as the critical study of research methods and their use (Grix, 2001). Grix, (2001) further highlighted that the term methodology refers to the choice of research strategy adopted in a study. According to Grix, (2001) research methodology is driven by certain ontological and epistemological assumptions and consists of research questions or hypothesis, a conceptual approach to a topic, the methods to be used, and the data sources. Easterby-Smith, Thorpe, & Lowe, (2001) defines methodology as a combination of techniques used to enquire into a given situation while Kothari, (2012) defines it as a way to systematically solve a research problem.

An issue in academic research is the conflating of the terms method and methodology (Grix, 2001; Kothari, 2012; Saunders, Lewis, & Thornhill, 2012). Although this study is not an investigation into the semantics or use of the terms, it is reasonably important to highlight this problem and provide some clarity to the utilisation of the terms in this study. Saunders et al., (2012) provides a clear distinction between method and methodology. According to Saunders et al., (2012) method refers to the techniques and procedures used to obtain and analyse data. In contrast, methodology relates to the theory of how research should be undertaken (Saunders et al., 2012). Research method can be referred to the techniques or procedures used to collate and analyse data and are inextricably linked to the research questions and sources of data (Grix, 2001). Kothari, (2012) uses methods and techniques interchangeably in the discussion of research methods and defines this as the methods, which are employed by the researcher in studying the problem of the research. Kothari, (2012) also alluded to the fact that research methods are linked to the research problems or questions (the unknown aspect of the problem), and the available data (the known dimension of the problem). This statement correlates with Grix, (2001, p. 29). It can be concluded that research methodology encompasses the strategies used for collecting and analysing data to answer and solve the research questions.

For the purpose of this study, the term methodology will refer to the strategy which maps out the approach to resolving the problem while the phrase method will refer to all the techniques adopted for data collection and data analysis.

1.4 Research Contribution to Knowledge and Practice

Due to a great focus on the technical aspect of FM in research i.e. maintenance, few studies have been carried out in the organisational and operational aspect of FM which involves IQ of AM. Thus, an understanding of how the quality of information is derived from this in FM has been obscured. It is important to realise that FM is not an entirely technical discipline, as the concept of integrated facility management (IFM) and total facility management (TFM) substantiates this in various texts (Atkin & Brooks, 2009; Bungar, 2012). Hence, this research will contribute to the advancement of understanding the phenomenon affecting IQ in FM by contributing to the exiting body of knowledge within IQ. It will address the limited amount of research in IQ within FM. This will be achieved by providing an empirical basis for assessing IQ of AM within FM discipline. It will demonstrate the use of a mixed method approach whereby robust analytical techniques will be applied to identify what latent factors affect IQ and how these can be applied in a framework to improve IQ of AM. These techniques are designed and intended to be replicable in future studies. The proposed framework within the study is designed to enable practitioners in FM gain further insight into the issues surrounding IQ with a view to ameliorate the effect of poor IQ in AM. The framework shall encapsulates the process which will enable the assessment of IQ in AM. The use of the framework shall also support evidence-based IQ improvement strategies. It is hoped that this will enhance efficiency of AM activities being delivered by FM practitioners in delivering AM.

1.5 Thesis Structure

As outlined above, this research aims to propose a framework to enable FM professional assess the quality of information used in AM programs. To achieve this aim, a thorough analysis of relevant information shall be carried out. Thus, the remaining part of this thesis is divided into six (6) chapters that will explore the phenomenon.

The second part of the thesis (Chapter 2) is the literature review, which presents elucidation of the concepts under investigation. Here the problem of IQ will be explored within the remit of AM programs undertaken by FM organisation. Also, this section will delineate the concept of FM and AM. The third chapter of the thesis (Chapter 3) will describe the research methodology and provide justification for the selected method adopted for the study. A critical discussion of the philosophical position that underpins the research will be outlined in the chapter. Within this section, the research analytical approach will be described to provide a clear understanding of the process.

The fourth (Chapter 4) and fifth chapter (Chapter 5) of the research present the data analysis. Based on the adopted research methodology, the fourth chapter provides the qualitative analysis, which is followed on by the quantitative analysis of the data. A discussion of the result shall be presented in both chapters and supported by evidence from extant literature. Following on from this is the discussion chapter forming the sixth chapter of the thesis (Chapter 6). This chapter provides a discussion of the key points identified from the literature review (Chapter 2), qualitative data analysis (Chapter 4), and quantitative data analysis (Chapter 5) respectively. Within the discussion chapter, the framework will be developed and evaluated. Finally, Chapter (Chapter 7) will provide the conclusion and synthesis of the research. Here the contribution to theory and opportunities for future research will be outlined.

Chapter 2 Literature Review

This chapter presents a review of the relevant literature pertinent to the research areas identified in Chapter 1 . It is aimed at understanding the concepts of information quality (IQ) in relation to asset management (AM) undertaken by facilities management (FM) organisations. The review is divided into three main sections (Figure 2:1):

1. Facility management (FM)
2. Asset management (AM)
3. Information Quality (IQ)

The first stream explores the concept and scope of FM. It is to be noted that the scope of FM is large hence this work will focus on those aspects relevant to the theme of this thesis i.e. AM and IQ. The second stream shall explore the principles of AM with a focus on planning, lifecycle management, risk, and financial and cost analysis. The rationale for focusing on these aspects directly stems from the effect IQ has on these. The third stream shall be on IQ, considered as a driver for effective AM in FM. In this stream, the theory of quality will be elucidated. In addition, a substantive theory of IQ will be presented and finally, methodologies that have been developed with the aim of assessing IQ shall be discussed.

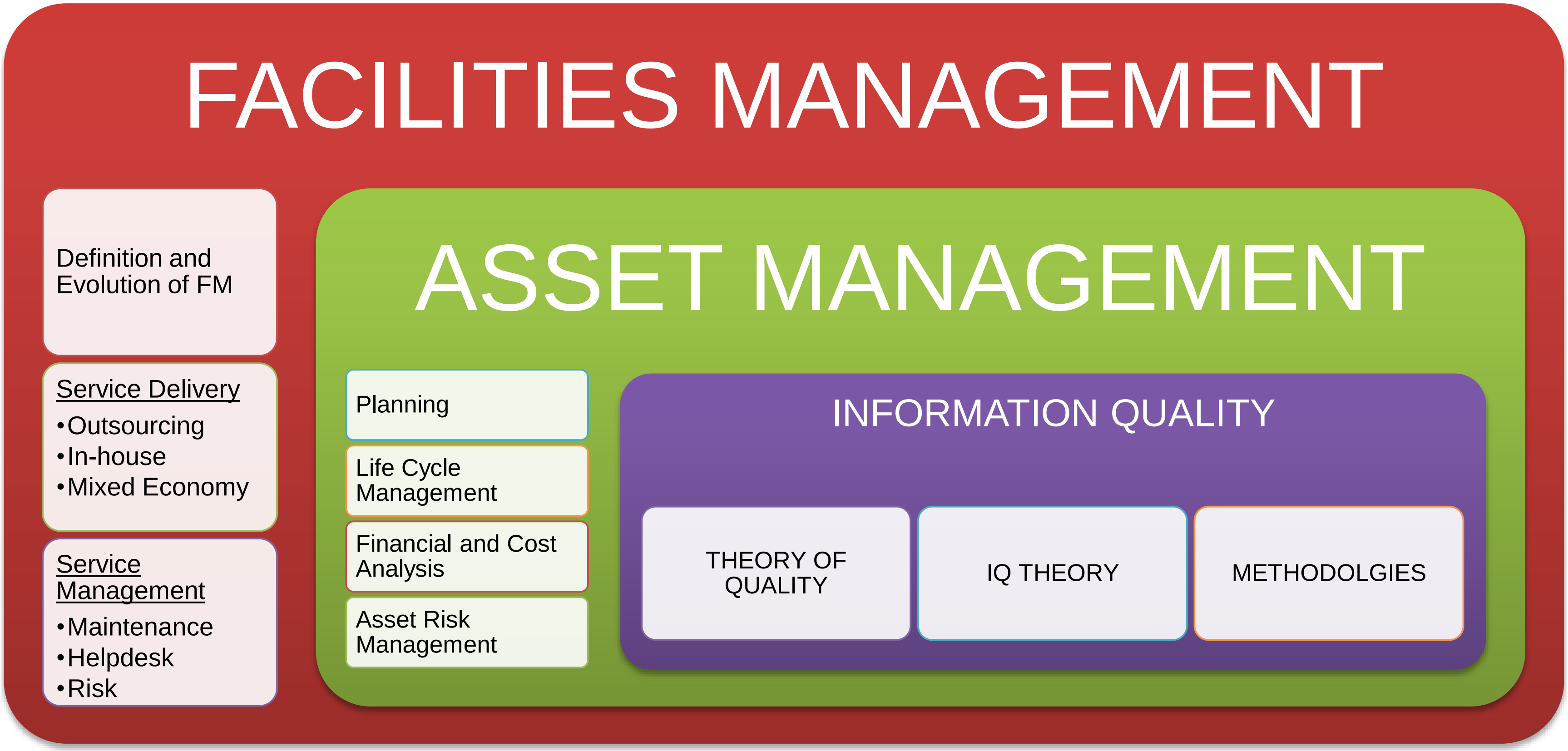


Figure 2:1 Chapter Structure

2.1 Facilities Management

It has been documented that organisations are motivated to maintain a level of competitive advantage in the midst of constant changing macro environment variables (Wiggins, 2009). This has ushered in a wave of support services, such as facilities management (FM), to enable organisations achieve the objectives of competitive advantage. Though FM is a relatively young discipline, it has developed a recognition as a required process for organisations that expend resources on people, the work environment, and the way in which work is coordinated (Rondeau et al., 2006). This is very prominent in the public sector but relatively new in the private (Cotts, Roper, & Payant, 2009; Interserve, 2013).

Within this context, the role of facilities management conveys an expectation that enables organisations achieve their set goal (Wiggins, 2009). de Lucy, (1991) also reports that FM is increasingly gaining recognition in large organisations because of the effects of rising cost. According to Wiggins, (2009) and Interserve, (2013), the FM organisations is tasked to ensure compliance, provide opportunities for the organisation, adopt new ways of working and seek to reduce operational cost while maintaining the right working environment standard. To understand this phenomenon, the evolution of FM, as a discipline, needs to be examined.

This section presents a review of FM. The evolution and definition shall be discussed in the opening paragraphs. This is followed by the discussion of FM operations, and finally the delivery model in relation to the organisational structure.

2.2 Evolution of FM

The evolution of FM as a recognised discipline has been motivated by the realities of the economic, political, technological, environmental, social, and legal situations in diverse economies (Rondeau et al., 2006; Then, 1996; Wiggins, 2009). Wiggins, (2009), traces the development of FM to changes occurring in the workplace in the 1960's. According to Wiggins, (2009) the introduction of computers and systems furniture into the workplace acted as a catalyst to the development of FM. However, the economic crisis of the 1970’s brought to light the significance of cost management due to rising inflation and oil prices (Rondeau et al., 2006; Then, 1996). As noted by Rondeau et al., (2006), the economic change in the early 1970s marked by the dramatic increase in the cost of materials and financing endeavours caused high levels of scarcity noted specifically for capital funds and materials. In addition to this, deregulations of monopolies required large companies to compete more efficiently in the marketplace leading to the evolutionary management of scarce resource and the transition to managing facilities as an asset (Rondeau et al., 2006).

The capital costs of property had also been a major concern in investment evaluations, which was exacerbated by the energy crisis in the late 1970s (Then, 1996). This raised a general awareness amongst building owners, business managers, and occupiers of the need to consider the economics of building occupancy in terms of recurring costs (Then, 1996). According to Rondeau et al., (2006) organisations possessing large facilities with extensive operating requirements and scarce capital budget developed and used practices accepted by professionals e.g. cost accounting, investment appraisals methods, and balance score cards. Such organisations with finite financial and human resources closely managed their day-to-day requirements as well as planned and develop facilities programs based on long-term goals, political realities and economic necessity (Rondeau et al., 2006).

A third significant factor that contributed to the development of FM was the formation and growth of professional bodies dedicated to promoting the discipline. For instance Wiggins, (2009) and Tay & Ooi, (2001) outlined, chronologically, the establishment of professional bodies such as NFMA, FMI, IFMA, AFM, IFM, BIFM, FMA, and EuroFM dedicated to the development of FM. Leaman, (1992) further added that professionalisation of FM emerged because of the challenge in managing building and the antecedent lack of knowledge in doing so. A fourth factor contributing to the development of FM was the introduction of new legislation that affected employees and organisation working practice and contract such as HSE, DPA, and CCL (Booty, 2009; Perry, 2009; Wiggins, 2009)

These factors elucidated above have brought upon issues of business continuity, security threat, risk management, corporate social responsibility, and financial instability on the organisation. They have contributed to the increased awareness of FM and the need to deliver efficiencies in the workplace through various delivery models such as PFI and outsourcing to specialist providers (Wiggins, 2009).

2.3 Defining FM

Defining FM is fraught with challenges for the reason it covers a wide range of disciplines thus earning the term “jack of all trades” (Tay & Ooi, 2001). According to Tay & Ooi, (2001) FM suffers from an acute identity crisis where the role and scope of duties differ considerably. This view has been supported by Thomson, (1990). Wiggins, (2009) also indicated that no standard definition has been established for FM due to lack of commonality between organisations teaching, practising, and representing facilities management. Noor & Pitt, (2009), noted that the plethora of definitions provide an extensive variance in understanding what FM is and how it operates within businesses. Wiggins, (2009), further argues that this phenomenon is a result of the dynamic nature of FM and its rapid development as a profession. Thus to understand and define FM appropriately, it is important to obtain a wider opinion on the issue.

Steenhuizen, Flores-Colen, Reitsma, Ló, & Branco Ló, (2014) noted that FM is relatively a young discipline, which evolved due to ever-changing macroeconomic environment. This development was further stimulated by the recognition of the efficiency, productivity, and cost-saving benefits that FM could offer (Steenhuizen et al., 2014). Steenhuizen et al., (2014) cites the definition of the European committee for standardisation (CEN) and defines FM as the integration of processes within an organisation to maintain and develop the agreed services, which supports and improves the effectiveness of its primary activities. This definition has also been ratified by the professional body British Institute of Facilities Management (BIFM, 2010a). According BIFM, (2010) FM encompasses multi-disciplinary activities within the built environment (BE) and the management of their impact upon people and the workplace. In support of

BIFM, (2010), Steenhuizen et al., (2014) put forward pillars associated with FM (Figure 2:2):

1. The three principles of FM - Place, People, Process
2. The supportive nature of FM
3. The multidisciplinary nature of FM

Rondeau et al., (2006) further elaborates on these pillars as follows:

1. A profession that manages and coordinates the interrelated people, process, and place issues and functions within an organisation
2. The practice of coordinating the physical workplace with the people and work of the organisation by integrating the principles of business administration, architecture, behavioural science, and engineering science
3. A profession that encompasses multiple discipline to ensure functionality of the BE by integrating people, place, and technology

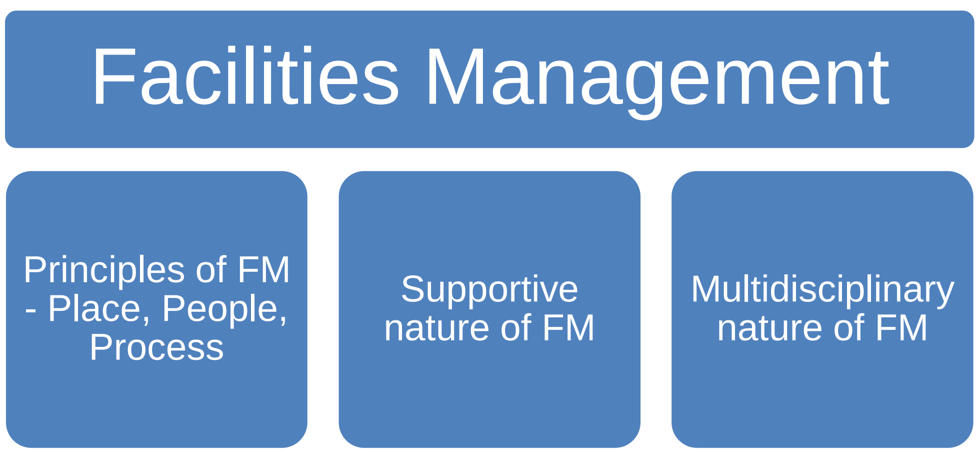


Figure 2:2 Schematic Description of FM Based on Steenhuizen et al., (2014)

According to Steenhuizen et al., (2014) the nature of FM differs geographically and possess different meaning depending on the country. For example, in the Netherlands FM is more service oriented while FM in the UK, Germany, and Austria is more technically oriented (Steenhuizen et al., 2014).

FM is about taking control, adding value, supporting the business, and ensuring that space and working environment enhance the productivity of the core activity of the organisation and staff (Wiggins, 2009). It encompasses multi-disciplinary activities within the BE and the management of their impact upon people and the workplace to ensure the optimal functionality of the BE (BIFM, 2010a; Cotts et al., 2009). At the corporate level, it contributes to the delivery of strategic and operational objectives.

Effective FM provides a safe and efficient working environment which is essential to the performance of any business (BIFM, 2010a). It seeks to gain the maximum efficiency and effectiveness of the space or working environment the organisation owns or leases which may be achieved by ensuring the appropriate support is available at the right cost, right quality, and in the right form (BIFM, 2010a). However, this entails the adoption of a proactive approach to ensure that organisations are able to deliver and sustain agreed levels of support services in a quality environment (BIFM, 2010a). Chotipanich, (2004) stressed that handling and managing support services that meets the needs of the organisation, its employees, and core operations is the key function of facilities management. Based on this argument, Chotipanich, (2004) adopts the definition of FM posited by Nutt, (2004), as the management of infrastructure resources and services that supports and sustains the operational strategy of an organisation over time.

For the purpose of this thesis, the definition of FM provided by BSI (2007) shall be adopted. According to the BSI, (2007), FM is defined as the integration of processes within an organisation to maintain and develop the agreed services which support and improve the effectiveness of its primary activities.

2.4 Service Delivery

As indicated from the previous sections, the prerogative of FM is the non-core functions of the organisation it serves. Defining core and non-core activities is nonetheless obfuscated by the overlap of such activities (Wiggins, 2009). Organisations rely on the primary (core) activities to achieve the strategic objectives set out in a plan. Wiggins, (2009) indicated that these primary activities are constantly influenced by changing market forces. Thus, it is crucial that these changes are managed within the organisation to remain viable and compliant (Wiggins, 2009).

Managing these change have been achieved through the support processes which in turn have a direct impact on the effectiveness of the core organisation processes (Wiggins, 2009). FM satisfies this relationship through a demand and supply model. Wiggins, (2009) posits that the objective within this context is balancing the demand for support services with supply of an optimised mix of service levels, capabilities, and costs constraints. In order to maximise the outcome of the value from these arrangement, it is crucial to align demand and supply of these services based on economic, organisational, and strategic objectives (Wiggins, 2009).

Well managed services enable an organisation to function at its most efficient and effective level, offering real added value to the organisation's core business (The Facilities Society, 2012). Providing these services have led to the development of concepts that focuses on procurement strategies, contracting out methods, performance monitoring, and measurement (Chanter & Swallow, 2007; Paz & Viriyavadhana, 1995). This has extended the range of services covered within the remit of FM, inadvertently causing it to becoming more complex (Payne & Rees, 1999; The Facilities Society, 2012). It's makeup consists of a mix of in-house departments, specialist contractors, large multi-service companies, and consortia delivering a full range of hard and soft services (BIFM, 2010a). To this end, service delivery forms the core functions of facility management. The mode in achieving this differs from organisation to organisation, which is dependent on individual company's policy, the nature of the building and services, and the use to which it is put (R. Rooley, 1987). However, errors in service delivery, as a result of poor technology implementation, poor information quality (IQ), documentation issues, and weak reporting has the potential to escalate beyond control and require costly management time and attention to resolve (Redding, 2014).

FM aims to provide management services that meet strategic long range and short term corporate requirements. This is achieved by combining innovative methods and techniques to accomplish productive and cost effective work environments (Rondeau et al., 2006). Particular considerations for FM are quality of life, cost-effectiveness, flexibility, and environmental consideration (Rondeau et al., 2006). As such, FM is becoming the focal point for large corporate organisation in providing a structured way to deal with non-core activities such as projects, planning, day-to-day change request, and building site issues (Rondeau et al., 2006). This requires informed and knowledgeable professional to address the challenges and opportunities within the scope of the BE.

As noted earlier, the range of services covered within the remit of FM has become more complex (The Facilities Society, 2012) with its makeup consisting of a mix of in-house departments, specialist contractors, large multi-service companies, and consortia delivering a full range of hard and soft services (BIFM, 2010a). To this end, the service delivery strategy adopted, based on specific company policy, by FM organisations have been grouped into (1) Outsourcing, (2) In-house (3) Mixed economy (Barrett & Baldry, 2003). A brief discussion of these strategies is made below.

2.4.1 Outsourcing

According to Perman & Scouller (2004), the source of the firm's added value lies in its ability to supply goods for which business and non-business customers are willing to pay in excess of all the costs incurred by the firm in supplying the service or goods. However, due to rising cost, the firm added value tends to diminish. Pressure to reduce cost have resulted in large enterprises adopting methods of strategic outsourcing of non-core operations enabling them focus on their core competencies to create and add value to their operations (Atkin & Brooks, 2009; Barrett & Baldry, 2003; Houston & Youngs, 1996; Pearce & Robinson, 2005; The Facilities Society, 2012). Strategic outsourcing seeks to focus long-term personnel and resources on core business requirement and a reduction in annual operational cost without loss in the quality of services provided (Rondeau et al., 2006)

Smith and Michael Pitt, (2011), noted that the main reasons for organisations to outsource their services tend to centre on reducing costs, enabling a focus on the core business, and benefiting from the expertise provided by specialist suppliers. Thus, outsourcing has become a dominant strategy in many institutions and organisations. Outsourcing is a philosophy adopted by organisation where they seek to obtain and leverage on skills inherently absent within the firm from an external source with a view to achieving some benefits (Perman & Scouller 2004; Pearce & Robinson 2005; Su & Levina 2011; Willcocks et al. 2011)

For facility managers, the greatest area of outsourcing activity occurs in the operation of the building of which cleaning, repairs, and maintenance takes a large portion of the activity (Interserve, 2013). Outsourcing these activities would bring along quality service at lower cost based on certain conditions being met (Lai & Yik, 2007) but this entails large transactions costs (Willcocks et al., 2011). FM can, therefore, be considered as a vehicle for planning and coordinating these to meet the goals of the organisation (Alexander, 1996; Barrett & Baldry, 2003; Smith & Pitt, 2011).

2.4.2 In-House

In contrast to outsourcing, an alternative method of providing facilities services is through an in-house arrangement. Here FM services are provided by personnel residing within the organisation (Barrett & Baldry, 2003). According to Cardellino & Finch, (2006) this approach to facilities service provision is characterised by a constant search for the best relationship between the building and the occupiers. The benefit of using this method lies in the FM team having expert knowledge of the facility and being able to respond to issues rapidly as they occur (Atkin & Brooks, 2009; Payne & Rees, 1999). This method can also help in resolving minor problems, routine maintenance, or non-specialised services (Chanter & Swallow, 2007). However, a downside to this approach lies in the significant investment in time and effort in keeping abreast with legislation and industry practices by managers whose remit may include management of services on a part-time basis (Atkin & Brooks, 2009).

2.4.3 Mixed Economy

An alternative to the methods provided above is the use of mixed-economy sourcing (Barrett & Baldry, 2003). This method uses selective outsourcing where 20%-80% of specialised services are outsourced and non-specialised service, reactive or routine services are retained in-house (Barrett & Baldry, 2003; Willcocks et al., 2011). Using the mixed economy method requires information about the cost of service provision. This takes into consideration the indirect and direct costs associated with the provision of the service with the view to obtaining the optimal mix (Atkin & Brooks, 2009).

2.5 Service Management

This section outlines the constituents of FM that contributes to its success. These include:

1. Risk management
2. Maintenance
3. Helpdesk

The management of facilities services is a complex process occurring within the operational phase of the building. The operation phase of facilities is very dynamic and comprises iterative phases and intermediate changes (Sebastian, 2011), where many actors with shifting agendas, roles, and responsibilities are actively involved. Within this context, operations is defined as services necessary to keep systems operating as designed or at a level that meets the operational goals of the facility (Lewis, Riley, & Elmualim, 2010).

The operation phase is regarded as the longest phase of the building lifecycle (Chanter & Swallow, 2007) and as a result, an overwhelming majority of cost incurred occur during this phase (Chanter & Swallow, 2007; Clayton, Johnson, & Song, 1999; Lewis et al., 2010; Wood, 2005). Lewis et al., (2010) posits that the lifecycle cost of the operational life of a building is circa 60% to 85% of the total lifecycle cost while the design and construction phase is about 5% to 10%. The bulk of activities carried out by the facility managers occur during the operations phase (BIFM, 2010a; Yik, Lai, Chau, Lee, & Chan, 2010) and involves daily and scheduled maintenance management activities, remodelling, replacement of components, and daily facility operations activities i.e. cleaning and catering (BIFM, 2010a).

Well managed services enable an organisation to function at its most efficient and effective level, offering real added value improvements to the organisation's core business (The Facilities Society, 2012). Three important factors contributing to success of the service delivery, regardless of the approach adopted, include risk management (RM), maintenance, and FM helpdesk support, which shall be discussed in the following section.

2.5.1 Risk Management (RM)

Risk management (RM) is an important function within FM in relation to service management. Payne, (2000) stressed the importance of understanding risk in the workplace. According to Payne, (2000) it is vital that all facilities managers understand the prescribed legislations concerning risk and put these in place to comply with the required regulation and guidance. This regulation is governed by the Health and Safety at work Act 1974 which places a legal duty on those who control premises to ensure the safety of employees (Payne, 2000). In this regard, the assessment of risk has to be robust, comprehensive, appropriate, and current (Payne, 2000). This view has been supported by TAH & CARR, (2000). However, according to TAH & CARR, (2000), where this is not instituted, the result is poor performance with increased cost and time delays.

Managing risk is often problematic because the communication of risks information tends to be poor, incomplete, inconsistent, and un-formalised (TAH & CARR, 2000). This problem emanates from a lack unified language, process model, and poor quality of information in ensuring risk is managed in a defined way (TAH & CARR, 2000). Thus, understanding and managing risk correctly enables all party involved in the FM process leverage the benefits of FM while ensuring that they operate within an acceptable risk environment (Redding, 2014). Redding, (2014) outlined typical risks associated with FM as follows:

1. Critical failures
2. Service provider underperformance
3. Financial underperformance
4. Cultural rejection
5. Loss of knowledge
6. Labour risk

2.5.2 Maintenance

Maintenance has been at the forefront of FM as buildings and assets have always been considered factors of production and the way they are managed directly impact upon staff productivity and service delivery (M. A. Hassanain, Froese, & Vanier, 2001; Wauters, Bram, & Wauters, 2005). Swallow and Chanter, (2007, pp. 19 & 21) have defined maintenance (using BS 3811) as *"…a combination of any actions carried out to retain an item in or restore it to an acceptable condition…"*. Payne, (2000) highlighted that maintenance, which is included in significant aspects of service level agreements (SLA) within the FM remit, forms the backbone of FM. Maintenance cannot be over emphasised as research has concluded that inappropriate maintenance can lead to sick building syndrome and loss in productivity of office personnel (R. Rooley, 2007; R. H. Rooley, 1993).

Two broad grouping for maintenance exist, reactive and planned maintenance (Chanter & Swallow, 2007; Hegazy, Ahluwalia, & Attalla, 2010; Hua, Sher, & Pheng, 2005; Lewis & Whittaker, 2012; Ni & Jin, 2012). The reactive maintenance deals with issues that occur on a day-to-day basis that may cause acute disruption to service while the planned maintenance consists of detailed and scheduled operations that identifies and mitigate problems that may occur in the future (Chanter & Swallow, 2007, pp. 128–135). According to R. Rooley, (1988) and Horner et al. (1997), maintenance can be sub-divided into three strategies:

1. Corrective maintenance: also referred to as failure-based or unplanned maintenance which often take places in an ad hoc manner in response to breakdowns
2. Preventive maintenance: also referred to as time-based maintenance, planned maintenance, or cyclic maintenance, is performed in accordance with a predetermined plan at regular intervals, which may be based on the concept of reducing the probability of occurrence of failure and avoiding sudden failure
3. Condition-based maintenance: Maintenance carried out in response to a significant deterioration in a unit as indicated by a change in monitored parameter of the unit condition or performance

Chanter & Swallow, (2007, p. 134) opined that a simple classification of maintenance into these standard is rather limited in value. Therefore by adopting the audit commission's[2] approach, Chanter & Swallow, (2007) provides an alternative division of maintenance as follows:

1. Strategic repairs and maintenance: Normally these items can be planned for because they can be foreseen and budgeted for. This represents work required for the long-term preservation of an asset
2. Tactical repairs and maintenance: these items relate to day-to-day work of a minor nature, in response to immediate need

It can be surmised that maintenance is a combination of services, actions, and management of resources to restore an asset condition to obtain maximum economic benefits and optimal performance. This comes as building operations have a major impact on the delivery of business efficiency and sustainability goals. The maintenance approach chosen to achieve these goals differs widely and will depend on the kind of asset being managed (Payne, 2000). The determination of demand for maintenance is rather a complex process, and many-a-time is a function of organisational structure and

[2] Audit Commission for local authorities in England and Wales (Chanter & Swallow, 2007, pp. 134 & 158)

policies, resource (human and financial), and information (information quality and information systems). To manage this situation, a structured and optimised approach to information quality is required.

2.5.3 Facilities Management Helpdesk

Rondeau et al., (2006) reported that there is a significant logistical problem experienced by organisation in creating and maintaining accurate, adequate, and responsive information systems relating to real property and FM. This has led to the development of helpdesk systems that enables the coordination of relevant information within FM.

Helpdesk represents the electronic interface between the customer and the facilities provider (Payne, 2000). They are considered to be a powerful management apparatus vital to FM information control (Payne, 2000). The computer-aided facilities management (CAFM) system is employed within the helpdesk to control a range of data and information, which include cost, material, performance, and response time (Payne, 2000; Rondeau et al., 2006). However, various nomenclature for CAFM also exist, which lends their definition to their origin (BIFM, 2010b), for instance, computerised maintenance management software (CMMS), facilities management software (FMS), total integrated facilities management (TIFM), computer-integrated facilities management (CIFM), and integrated workplace management system (IWMS) (BIFM, 2010b). Regardless of the name attributed to it, these systems perform similar function in FM. The CAFM is an encompassing software that links together various functions and activities to produce and all-embracing electronic data file used in planning and controlling the functions of FM (Payne, 2000; Rondeau et al., 2006). This explanation has been depicted in Figure 2:3.

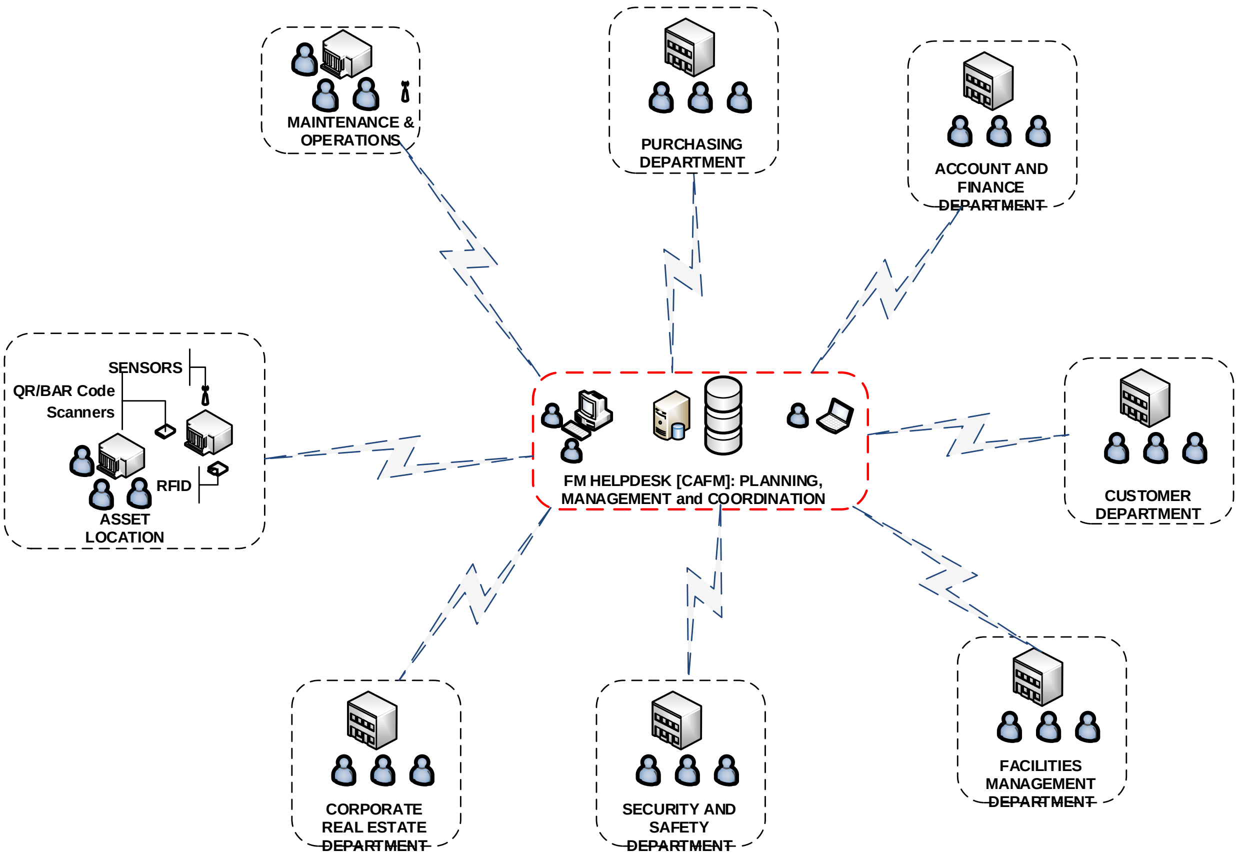


Figure 2:3 CAFM in FM Helpdesk

According to BIFM, (2010b) the CAFM software applications assist in the monitoring, management, and planning of operational activities and expenditure, standards, regulatory compliance, and capital budgeting. Additionally, Rondeau et al., (2006), posits that CAFM can alleviate problems of timeliness, completeness, comprehensiveness, and uniformity of management information on FM.

Finally, Payne, (2000) noted that helpdesk ensure that information taken are meaningful to provide relevant feedback. They have been attributed to influence and play a significant role in improving the quality of information (Baškarada & Koronios, 2014). According to Baškarada & Koronios, (2014) the helpdesk provides assistance with locating and accessing information elements and products as well as providing advice on how to record, present, and secure information. A CAFM Database Schema configures the relevant tables in an entity relationship (ER) that ensures information integrity and accuracy facilitates this. In essence, the helpdesk is regarded as the custodians of IQ in organisations.

2.6 Asset Management (AM)

This section introduces the concept of AM in relation to FM. It has been acknowledged that AM is a discipline in its own right (Rondeau et al., 2006). AM as a discipline has its origins in the field of finance and economics (Berzins, Liu, & Trzcinka, 2013; Frolov, Ma, Sun, & Bandara, 2010; Woodhouse, 2001). The principal focus is the optimisation of financial assets and securities to minimise the associated risks (Michaud, 2008). However, this principle has transcended into the fields of engineering and found its way into FM. In the field of FM, it presents its self as an innovative concept in managing risk, performance, and cost thus having a strategic focus (Rondeau et al., 2006). The strategic focus involves long-term planning for the organisation that takes into context its vision, mission, values, business policies, objectives, and management of risk (Woodall et al., 2012). AM in the field of FM has a strong focuses on the physical asset, within the property domain, being managed by FM service providers. In respect to this study, FM refers to the service providers that engage in the management of physical assets, thus using AM as a mechanism in attaining value for the stakeholders. Thus, it can be argued that AM in FM sits at the strategic level of the organisation (Figure 2:4). However, the limited quantity of literature focusing on the strategic principles and benefits of AM in FM suggests that this view is rarely acknowledge.

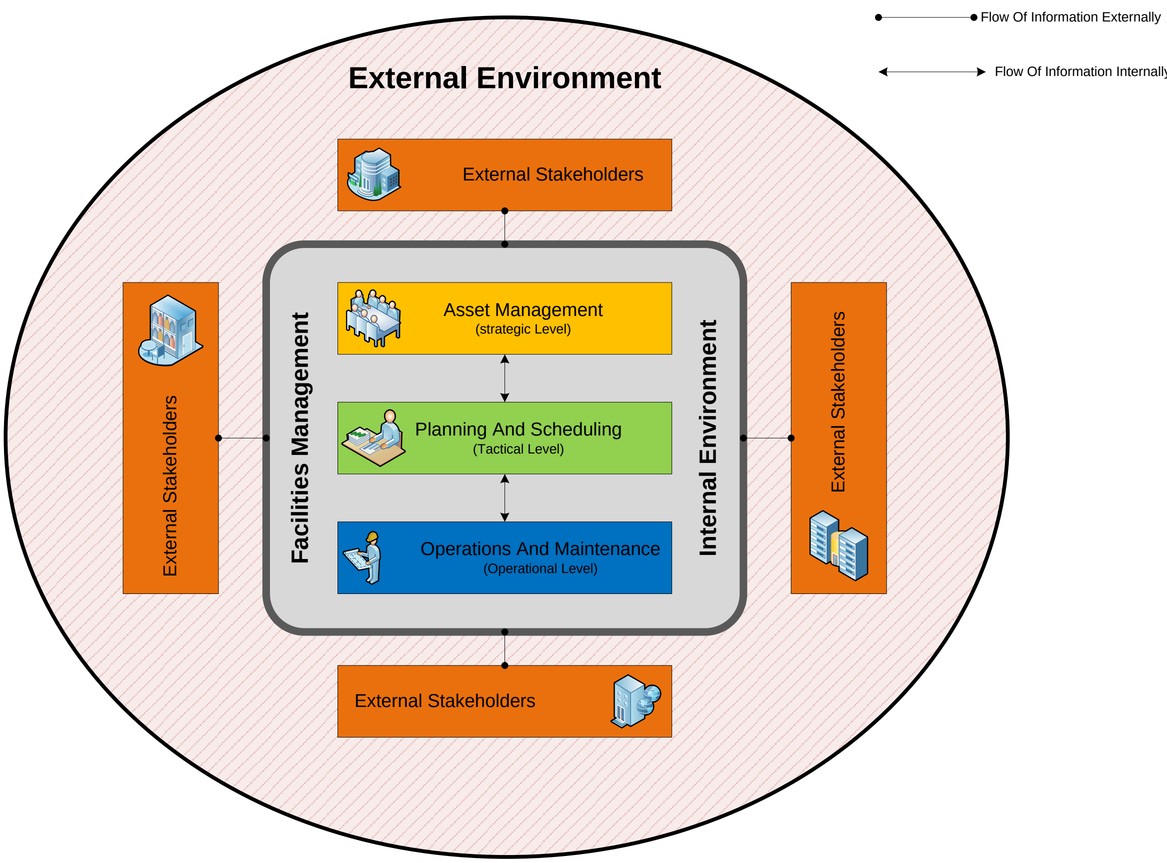


Figure 2:4 The Relationship between Asset Management and Facilities Management

Many factors have given rise to the need of AM in large commercial organisations (Alexander, 2003; Chanter & Swallow, 2007; Lavy & Shohet, 2007; Paz & Viriyavadhana, 1995). For instance increased competition, increased cost of construction, productivity concerns, statutory requirements, maintenance demands, customer responsiveness, and continual improvement of quality (Alexander, 2003; Lavy & Shohet, 2007). According to Wauters (2005) and Rondeau et al. (2006), an organisation's second largest expense is the property costs which are relatively fixed component of the budget and also the largest item on the balance sheet. They account for as much as 15% of turnover and 25% of all fixed asset (Alexander, 2003). Consequently, it is important that they be managed to add value to the organisation. Indeed Schuman & Brent, (2005) suggest that operating and production enterprises are pressured to attain unprecedented levels of asset availability, reliability, operational effectiveness, and maintainability while increasing revenues, and customer satisfaction and simultaneously reducing capital and operational support. To this end, building owners and managers are tasked to seek methods of better utilisation of building assets to achieve corporate goals and visions (Alexander, 2003; Jones & White, 2012).

As noted above, buildings are significant assets and the facility manager would typically be concerned with issues such as physical, functional, and financial performance of such assets (Wauters et al., 2005) based on proper operation and management (Lai & Yik, 2007; Lewis et al., 2010). Its success requires an integration of knowledge, technologies, processes, and people (Lewis et al., 2010). This has been termed integrated asset management (IAM) by Rondeau et al., (2006), which comes in as a backdrop of corporate organisation redirecting their strategy towards a strengthening of infrastructure management. Rondeau et al., (2006) defines IAM as the sum total of all those activities leading to infrastructure that is appropriate to the cost-efficient delivery of service. These activities include:

1. Identification of the need for asset
2. Provision of the asset
3. Operation of the asset
4. Disposal and effective removal of the asset from the organisation portfolio

Jones & White, (2012) provides a snapshot of different definition of AM made by different authors with the aim of giving a holistic picture of the nature of AM. These have been pooled together by Jones & White, (2012) as follows:

> *"…asset management is a key part of business planning which connects, at a strategic level, decisions about an organisation's business needs, the deployment of its assets, and its future investment needs…"*

> *"…asset management…lies at the level of corporate resource management…[as]...feature of thinking at a strategic level, which means matching future capabilities to a future environment in order to achieve defined outcomes…[which]…aligns itself with strategic resource and ICT management at the business thinking level…"*

"…a structured, holistic, and integrating approach for aligning and managing over time service delivery requirements and the performance of property assets to meet business objectives and drivers…"

Rondeau et al., (2006), describes AM as the administration, operation, and management of a real property portfolio including land, facilities, and legal commitment controlled by an owner, tenant, developer, or property owner. Rondeau et al., (2006) further adds that it is a tool to match corporate infrastructure resource planning and investment with corporate service delivery objectives. Jones & White, (2012) describes AM as "*the process which aligns business strategies, thus ensuring the optimisation of an organisation property asset in a way, which supports its key business goals".* Woodall et al., (2012) provides an elaborate definition of asset management as follows:

"…a systematic and coordinated activity through which an organisation optimally manage its assets and their associated performance, risks, and expenditure over their lifecycle for the purpose of achieving its organisational strategic plan…" (Woodall et al., 2012)

To this end Rondeau et al., (2006) attributes the following criteria to asset (Table 2:1):

Table 2:1 Asset Attributes by Rondeau et al., (2006)

Attribute	Criteria
Value	All asset must have a value
	An asset has an enduring value
	Assets must distinguish between physical and useful life
Form	Asset can be current or non-current
	Asset can be financial, physical, or intangible
Purpose	Asset should exist to support service delivery strategy
	Asset are only one input in the corporate planning process
	Asset must have a service potential

It can be established, from the above, that AM constitutes strategic and integrated sets of comprehensive processes to gain greatest lifetime effectiveness, utilisation, and return from physical assets (Schuman & Brent, 2005). These processes include planning, lifecycle management (LCM), financial and cost management, and risk management (RM) (TheIAM, 2012). These are discussed briefly below.

2.6.1 Planning

Planning has a distinct significance in AM programmes. This helps in setting the direction of action to achieve specific goals related to AM based on operational requirement (Cotts et al., 2009). The mission of planning is to reduce the uncertainty and control the risk inherent in business decisions by directly interfacing with the business cost and return structure (Cotts et al., 2009; Klein, 2004; Rondeau et al., 2006). Rondeau et al., (2006), identifies two types of planning performed by the facilities manager for AM purposes:

1. Strategic planning
2. Operational planning

Strategic planning, depicted in Figure 2:5, provides the overall corporate direction subjects to the external environment, resources available, and resources obtainable (Rondeau et al., 2006). This considers the broad approaches or general plans needed to achieve certain long-term objectives (Rondeau et al., 2006). Strategic planning typically involves complex and abstract issues of which their effect on the organisation is difficult to anticipate (Klein, 2004; Rondeau et al., 2006). Klein, (2004) further noted that strategic planning is a tool for positioning the corporation portfolio to respond to future business requirements. However, as time horizon for investment planning shrinks and moves closer to the plateaus of operational and project planning, the traditional concept of strategic planning is fast becoming obsolete (Rondeau et al., 2006). Nonetheless, knowledge of long-term economic and social factors are significant in the creation of a viable AM plan (Rondeau et al., 2006).

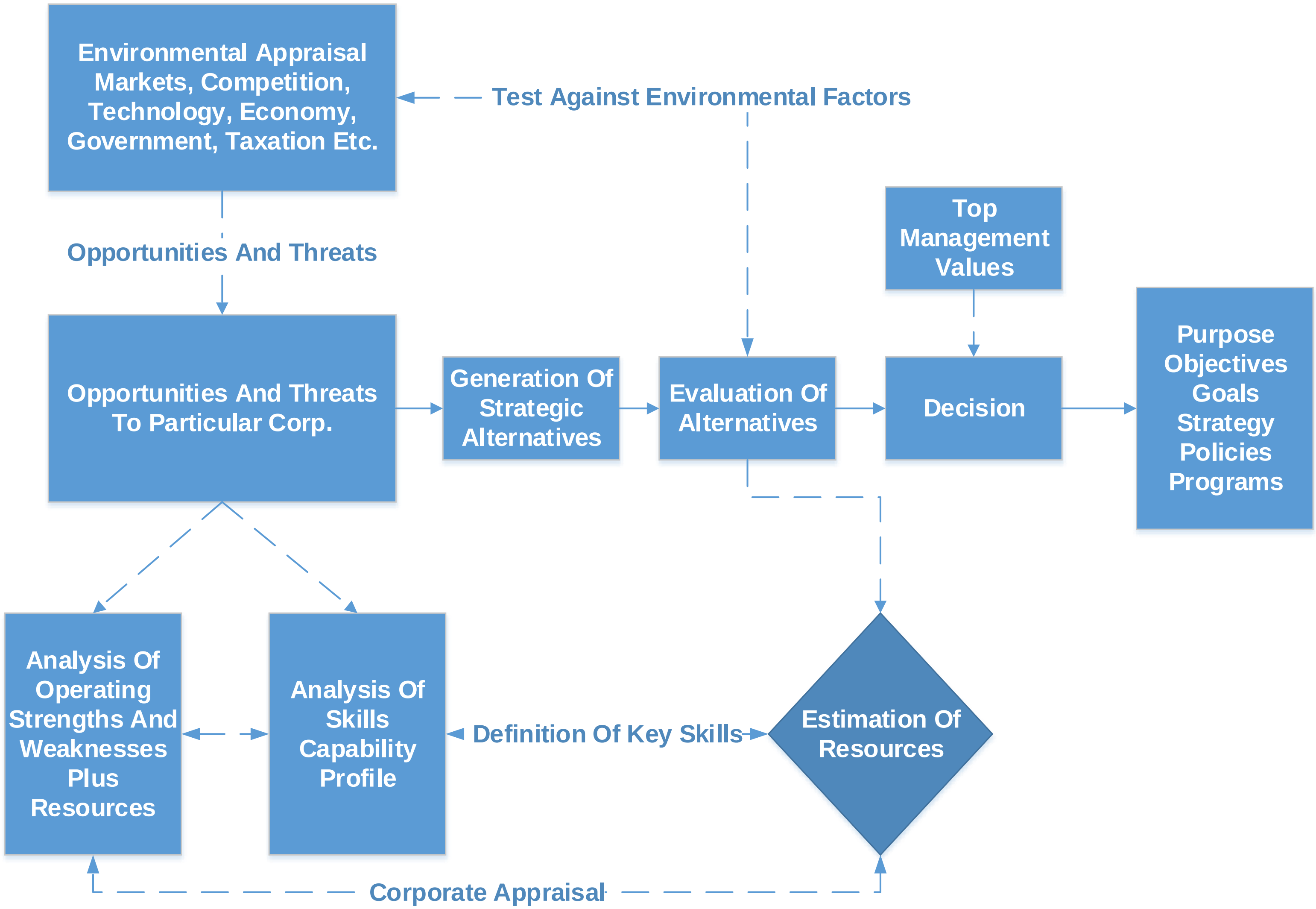


Figure 2:5 Strategic Planning Key Steps

Operational planning involves the detailed specific aspect of implementing strategic plans or changing current operating activity (Rondeau et al., 2006). Slack, Chambers, & Johnston, (2007) describes operational planning as concerned with operating specific resources on a day-to-day basis while ensuring availability of materials and other variable resources in order to supply goods and services. Also, this constitute specific activities which provides the systems, procedures, and decisions that bring different aspect of supply and demand together (Slack et al., 2007).

AM planning occurs on a long-term basis, but with contingency plans that can accommodate short-term deviations in business projections (Cotts et al., 2009). According to Cotts et al., (2009) the issues being addressed in AM planning include:

1. Capacity requirement forecast
2. Asset location, relocation, expansion and consolidation
3. Asset acquisition, utilisation and divestiture
4. Life cycle costing and productivity
5. Financing including the capital budgeting plan
6. Implementation policies and procedures
7. Standards

These issues are fed into an annual operating plan (AOP), which represents the short-term part of the budgeting cycle carried out at the departmental level (Rondeau et al., 2006). This involves the collation and combining of several operating units plans detailing relevant forecast on a short-term basis. Such plans are further analysed and synthesised with the overall strategic plan for facilities. Sadly, Rondeau et al., (2006) noted that facilities managers are oftentimes excluded from the planning process which consequently has a detrimental effect on the organisation.

Successful execution of AM plan depends on information exchange that supports the plan process (Rondeau et al., 2006). Policies that govern the business operations e.g. investments preferences or customer service are subsequently integrated into the information exchange process (Cotts et al., 2009). In this regard, it is imperative information gathered from relevant sources is of high quality.

According to Cotts et al., (2009) satisfying the IQ need using a unified system presents a challenge in AM. The principal information management tool used by practitioners in AM is the enterprise resource planning system (ERP) (Moon, 2007). These systems have a fundamental impact on the strategy and structure of AM organisation (Holland, Shaw, & Kawalek, 2005). However, they may lack the required structure to satisfy the needs of smaller organisations due to complexity (Hunton, Wright, & Wright, 2005). Therefore, there is the need for information management improvement (Cotts et al., 2009).

2.6.2 Life Cycle Management (LCM)

At the core of AM is lifecycle management (LCM) and Koronios et al. (2005) noted that the objective of AM is to optimize the lifecycle value of assets by minimizing the long-term cost of owning, operating, maintaining, and replacement while assuring the required levels of reliable and uninterrupted delivery of quality service. LCM concept can be considered as a system or framework integrated at all levels of the organisation (marketing, purchasing, research and development, product design, strategic planning, corporate reporting) to improve organisations goods and services (Hunkeler et al., 2003). In simpler terms, it involves the holistic management of physical assets to achieve the stated outputs of the enterprise (Nicholas A. J. Hastings, 2010). Hastings, (2010) acknowledged this as a basis of planning resources and budgets for support of the asset. Schuman & Brent, (2005) posits that to gain greater value; the AM process should extend over the complete life cycle (Figure 2:6).

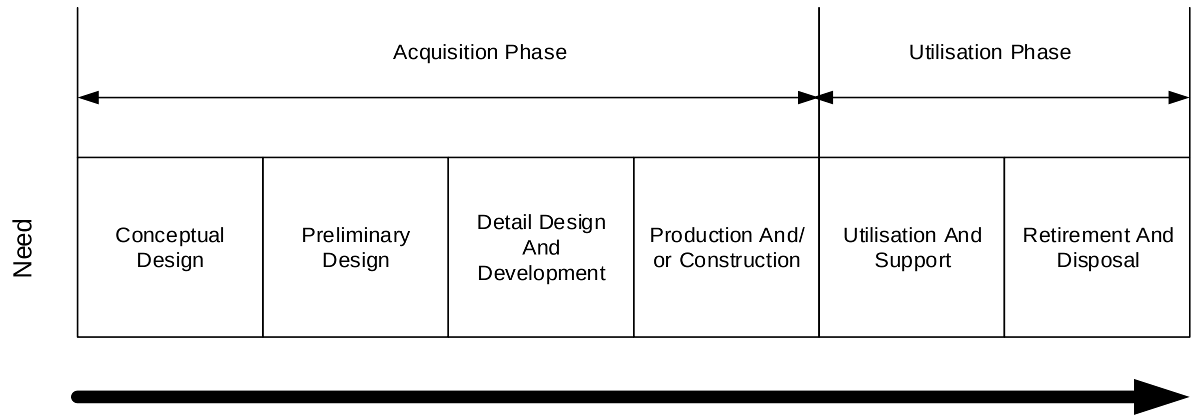


Figure 2:6 Life Cycle Phases of Asset Systems (Schuman & Brent, 2005)

LCM is an approach for decision-making within organisations (Hunkeler et al., 2003). It is an information intensive activity of AM (S. H. Lee & A. Haider, 2014). A comprehensive approach to LCM guarantees that effective sharing and coordination of information assures the processes used across AM projects are consistent (Schuman & Brent, 2005). However, information utilised during LCM is prone to change dramatically due to continuously changing operational and competitive environment (S. H. Lee & A. Haider, 2014).

Sources of information for LCM range from requirement of maintenance from the manufacturers to specific legislation covering the scope of the asset Hastings, (2010). However, fragmentation and isolation of processes and activities across organisation resulting in poor IQ presents a challenge in achieving effective LCM (El-Akruti & Dwight, 2013; Schuman & Brent, 2005). This is seen to affect the quality of information in the decision-making process in organisation (Ergen, Akinci, & Sacks, 2007; Hunkeler et al., 2003). Based on this argument, the consideration of IQ issues is critical when assessing the LCM and decision-making processes in FM (Koronios et al., 2005).

2.6.3 Financial and Cost Analysis

An important aspect relating to AM is financial management (FinMgt). This requires possessing adequate resource to ensure effective management of building assets. According to Cotts et al., (2009) the facilities manager is concerned with the following specifics of FinMgt: life-cycle cost analysis (LCCA), financial forecasting, macro level estimating, and capital programs financing.

LCCA allows the comparison of two different options of different expected total cost of one option over its expected life (Cotts et al., 2009). According to Hastings, (2010) this enables facilities managers make decision on the cradle to grave cost estimation of acquiring, commissioning, operating, maintaining, and disposing of assets. LCCA acknowledges that the company buys into a chain of cost when taking up the operation of a facility (Cotts et al., 2009).

A second factor that dovetails into LCCA is the financial analysis. This entails financial forecasting which bridges the assessment of financial resources for a plan and the allowable budget (Cotts et al., 2009). Financial forecasting utilises a variety of techniques to obtain a budget as stated by Cotts et al., (2009) such as:

1. Regression analysis
2. Moving averages
3. Econometric modelling
4. Exponential modelling
5. Delphi method
6. Simple projection

These techniques rely on a combination of historical information, flux caused by new requirements, and unit cost of proposed activity (Cotts et al., 2009). Further to this, Cotts et al., (2009) indicated that macro level estimating provides financial guidance on allocating budget and lists three types of macro level estimate to include: (1) informal estimate, (2) generic estimate, and (3) comprehensive estimate. The differentiator of these methods of estimate is determined by the level of detail attributed to each estimate, with informal estimate being the least detailed and comprehensive estimate being the most detailed (Cotts et al., 2009).

Finally, capital program financing encompasses the function of the level of capitalization required for competing projects (Nicholas A. J. Hastings, 2010). This requires information on the net amount of the investment required for a project, the cash flow expected from an investment, and the organisation acceptable rate of return on investment (Nicholas A. J. Hastings, 2010). Capital program financing utilises the following tools (Black, 2005):

1. Payback period
2. Net present value (NPV)
3. Internal rate of return (IRR)
4. Accounting rate of return (ARR)

These approaches have the potential of evaluating the options available in meeting the same requirement by permitting the comparisons of actions having different life expectancies (Cotts et al., 2009). LCCA information about assets in terms of cost and life expectancy allow accurate life cycle calculations and to assist managers with AM programmes (Ashworth, 2015). But the lack of accurate and complete information has been found to be a significant challenge to proper life cycle cost and financial analysis (S. Lin et al., 2007). Hence, Cotts et al., (2009) noted that this is seldom practised in the profession.

2.6.4 Risk Management (RM)

Risk is an inherent feature of AM, which has an effect on the objectives set by organisations (Purdy, 2010; TheIAM, 2012). The process of managing risk enables a controlled method for an organisation to maximise asset value and deliver its organisational strategic objectives (TheIAM, 2012). TheIAM, (2012) further elucidates on the purpose of RM as an enabler within organisation to optimise AM decision-making vis-à-vis providing a consistent methodology of assessment and reducing the levels of uncertainty.

Risk has been defined as the effect of uncertainty on objectives (Purdy, 2010). It is also seen as the possibility of incurring misfortune or loss (B. Williams, 2003). Purdy, (2010) further explains that the consequence of an organisation setting and pursuing objectives against an uncertain environment is risk in its self. Furthermore, uncertainty arises from internal and external factors and influences an organisation has no control over but may cause a failure or delay to achieve certain objectives (Purdy, 2010). In this context, three stages of risk have a significant influence on AM decision-making within the organisation (B. Williams, 2003). This is shown in Figure 2:7.

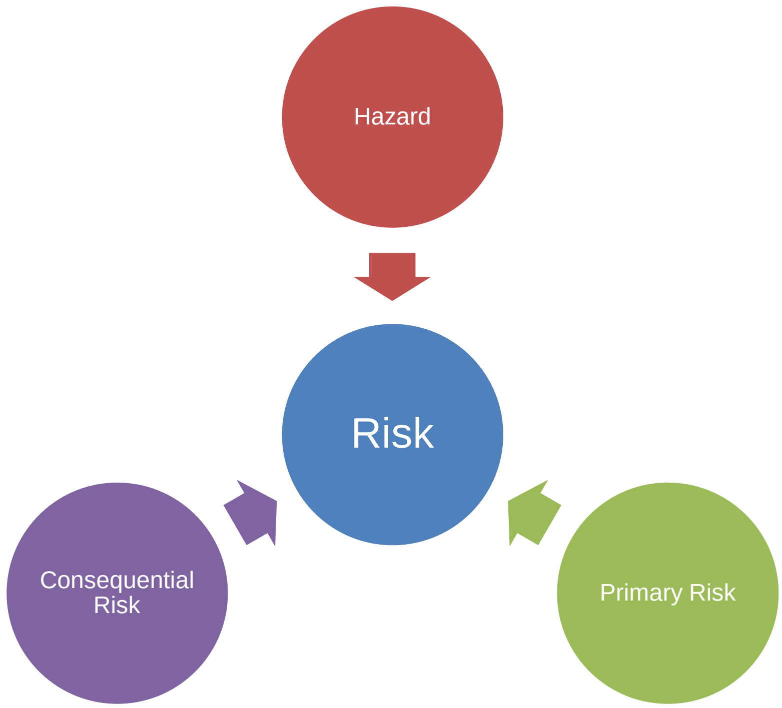


Figure 2:7 Stages of Risk Determination (Williams, 2003)

Hazard denotes a source of danger that increases the likelihood of an uncertain event occurring i.e. the primary risk (B. Williams, 2003). The severity of the consequences of such an event is known as the consequential risk which is addressed by the application of severity weighting during appraisal of risk (B. Williams, 2003). RM entails an iteration of activities that identifies, analyses, and generates response strategies throughout the lifecycle of AM programs to ensure set objectives are met (Figure 2:8) (BSI, 2009; Dikmen, Birgonul, Anac, Tah, & Aouad, 2008).

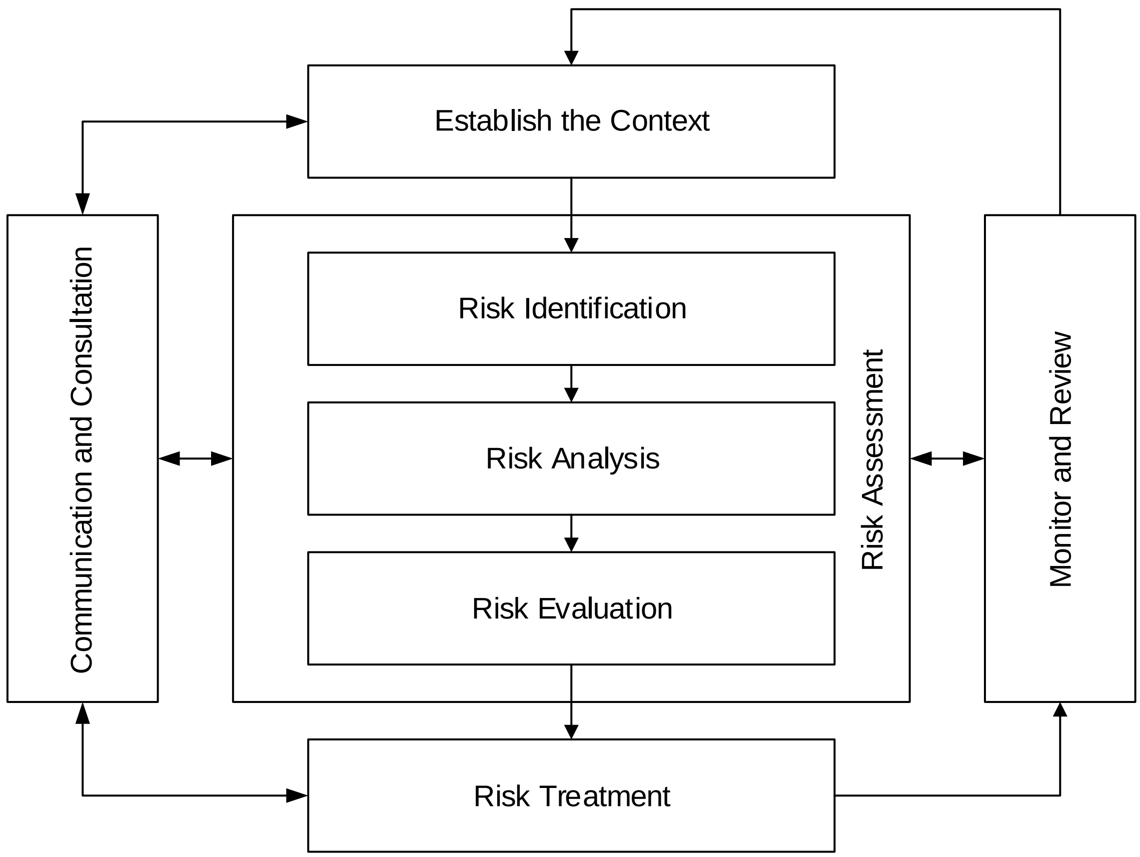


Figure 2:8 The Risk Management Process (BSI, 2009)

RM is an integral part of all processes which explicitly takes account of uncertainty and contributes to the demonstrable achievement of objectives and improvement of performance (BSI, 2009). According to BSI, (2009) the inputs to the process of managing risk is based on the sources and quality of information such as historical data. When the quality of such information is poor, is causes a variety of risks in an organisation (Borek, Parlikad, Woodall, & Tomasella, 2014). The information of each asset must be acquired in a timely, complete, and concise manner to find the contribution each asset makes to the corporate product portfolio (Sheble, 2005).

Several methods have been postulated to ensure that risk information is adequate for the purpose of RM. Examples include: (1) knowledge driven risk management process (Dikmen et al., 2008), (2) fuzzy approximation and composition in defining the relationship between risk sources and performance consequences (Carr & Tah, 2001), (3) hierarchical risk breakdown structure (HRBS) (TAH & CARR, 2000), and (4) weekly risk report (WRR) (Perrenoud et al., 2014). However, poor, incomplete, and inconsistent communication of risks have been found to be detrimental to risk management (TAH & CARR, 2000).

2.7 The Role of Information Quality in AM

In order to obtain the benefits of AM as highlighted above, it is important to ensure that IQ factors are sustained to high levels in the organisation. In a recent study conducted by Interserve, (2013) it was identified that 92% of FM practitioners considered better management information as an important factor in building a successful client-partner relationship. The previous sections have also elucidated the effects the quality of information have on the processes of FM and AM. According to Qlik Technologies Inc, (2014) IQ factors such as collaboration, visibility, and efficiency enhances AM. Collaboration refers to the internal collaboration between departments. This is essential to reduce cost and work towards a common goal (Qlik Technologies Inc, 2014). With regards to visibility, increased collaboration yields increased visibility (Qlik Technologies Inc, 2014). This can provide an accurate picture for effective analyses and measurement enabling early identification of potential opportunities while efficiency is vital to maximise profit and competitiveness (Qlik Technologies Inc, 2014). Collaboration, visibility, and efficiency necessitates effective utilisation of information (Qlik Technologies Inc, 2014). According to Qlik Technologies Inc, (2014) information has been found to be a significant competitive advantage in asset-intensive companies. Therefore, precise collaboration, facilitated by the quality of information, with the entire business is required for effective AM.

Koronios, Lin, & Jing, (2005) also noted that the performance of AM processes rely on the interdependent components of people, organisation structure, and information. Thus, these should be managed as a set of unified enterprise resources at higher levels in the organisation to achieve targeted corporate performance (Koronios et al., 2005). Koronios et al. (2005) also suggested that organisations should focus on the management of these interdependencies, which drive their operations, from a strategic perspective. Following on from this, the next section introduces the concept of IQ in detail.

2.8 Information Quality (IQ)

Information quality (IQ) within the scope of FM is significantly an under-researched area and thus leaves opportunities for relevant contribution. The impact of the quality of information on any operations is significant (Alenezi, Tarhini, & Sharma, 2015) and has a lasting effect on the outcomes of the operations from decision-making at the strategic levels to the performance of the actual job at the operational levels. Levis, Helfert, & Brady, (2007) argued that IQ is highly sought after for decision-making, avoiding failure, reducing cost, and gaining competitive advantage. It was further pointed out by Levis et al., (2007) that the goal of IQ management is to increase the value of high-quality information asset as 10% - 20% of a firm's revenue is lost due to IQ issues. To this end, Hostettler & Delez, (2006) argues that adequate IQ secures timely and accurate basis for decision-making, supply chain efficiency, information technology business case realisation, and reduction of transaction costs for an organisations. Despite these benefits, organisations struggle with the quality of information used in their operation which leads to significant failures (Hostettler & Delez, 2006; Woodall et al., 2012).

Within the BE the effective use of assets have been the principal concern for good management practices (K. Brown et al., 2014; Too, 2010b). Also, Brown et al., (2014) indicated that other concerns have emanated to foster a strategic view of asset. These concerns relates to increasing resource scarcity, degrading environment, and climate change (Brown et al., 2014). As such a shift towards IAM practice which allows performance improvement and future investment planning has taken precedence in the decision-making of managers and stakeholders in AM (K. Brown et al., 2014; Too, 2010b). Decision-making is one of the many important activities of AM undertaken in FM. As seen from the preceding sections, decision about costs, expenditure, investments, maintenance, risk, resource scarcity, and environment requires a level of quality information.

As cross-functional groups, involved in AM within FM, are charged to make choices rapidly, with increasing degrees of uncertainty, decision-making is becoming increasingly complex (Hunkeler et al., 2003). However, there is little importance placed on the quality of information used for AM programs in FM, as evidence from a lack of research in the area. As pointed out by Alenezi et al., (2015) whatever benefits accrued from the implementation of decisions concerning the aforementioned will be dependent on the quality of information and the systems supporting such information. However, the quality and amount of research in this area with specific reference to FM leaves much to be desired. This review aims to fill this gap, by identifying research that has been carried out to investigate the concept of IQ as well as the impact on service operations.

Information is considered a significant requirement in the management of numerous types of operations (Alexander, 1992; Kaya, 2011; Madritsch & May, 2009). This is defined as intelligence derived by perception (B. Williams, 2003). Within the BE, to comply with statutory and financial obligations as well as being able to obtain optimal use of and benefit from facilities, effective and efficient use of asset related information is necessary (BSI, 2012). This requires a clear understanding of the various types of information needed for day-to-day management of the facility throughout its life (BSI, 2012). However, the amount of information intended for management can be substantial and demands a structured approach (BSI, 2012).

In relation to this, the concept of FM assumes responsibility for safe and correct operation of the BE, which extends to the well-being of occupants and other users (BSI, 2012). This goes beyond concerns of the technical aspect of the asset to cover a myriad of issues for which owners and those acting on their behalf have specific responsibilities and accountabilities (BSI, 2012). According to BSI, (2012), information needed for these purpose might be found in different parts of the organisation and, in some cases, might not be available. Thus knowing which information an organisation needs to collect, maintain, update, communicate, and control can prove challenging. BSI, (2012) further points out that the cost of delivering an asset within FM in the first instance includes the cost of producing and managing information. Williams, (2003) acknowledged that good information is a scarce commodity requiring the right tools and management resources to harness its potential. However, Williams, (2003) goes further to state that the use of quality information to modify AM plans is limited. By considering the entirety of the information required to support the asset, owners and operators can better understand their current and likely obligations and gain a variety of benefits from understanding the information quality concerns (Alenezi et al., 2015; BSI, 2012; de Lucy, 1991)

The focus on the technical aspects of quality of information has been the dominant approach to IQ management whilst paying little attention to the soft systems i.e. the human side (Hostettler & Delez, 2006; Levis et al., 2007). Though technology can improve the reliability and flow of information and the speed at which it is communicated (B. Williams, 2003), IQ is not primarily an issue of informatics. Thus, there has to be a sufficiently developed understanding of the principles and practices embodied in information management and how information can be managed in the best interest of the organisation managing the asset (BSI, 2012). According to BSI, (2012) the extent and nature of processes for managing asset related information should be determined within organisation management strategy.

Jylhä & Suvanto, (2015) conducted a study on the impact of IQ in FM from a lean management perspective. The principal focus of this study confirmed that poor information produced significant waste activities within the functions of FM causing three main effect:

1. Time wasted in searching for information
2. Extra work being performed due to poor information quality
3. Lost potential due to poor information quality

Numerous factors resulting in poor quality of information thereby presenting a negative effect in facilities management were identified by Jylhä & Suvanto, (2015). For instance, as observed, information in FM emanates from several sources and formats e.g. formal or informal, emails, meetings, and reports (Jylhä & Suvanto, 2015). Since the mode and media varies widely, the information produced are susceptible to quality problems. This subsequently affects the choice of users way of working (Jylhä & Suvanto, 2015). For instance:

1. Poor quality of information generates a lot of searching due to
    a. distribution of information existing in non-standardised forms or standards not adhered to
    b. an overload of information or information drought (Jylhä & Suvanto, 2015)
2. Poor quality of information generates extra work required to increase the reliability, validity, completeness, and readability of information (Jylhä & Suvanto, 2015)
3. Poor quality of information results in lost potential where investment made in information is not used (Jylhä & Suvanto, 2015)

According to Jylhä & Suvanto, (2015) poor IQ aggravates the overload of work in FM. A study of the effect of poor IQ conducted by English, (1999) categorised cost of poor information quality as:

1. Process cost i.e. cost associated with the re-execution of the process
2. Opportunity cost i.e. cost due to lost and missed revenues

According to English, (1999), the cost of poor IQ is contextual and depends on the perspective in which it presents its self. This makes evaluation particularly challenging as the same value, and the corresponding level of quality has a different meaning depending on the recipient (Batini et al., 2009). Jylhä & Suvanto, (2015) also noted that information is a critical enabler of the physical flow of production. Thus, improving the quality of information can yield significant benefits to an organisation overall efficiency, competitiveness, and responsiveness. This statement has been corroborated by Chaffey & Wood, (2005).

It is important to highlight here that information is data that is processed, manipulated, and organised within a context to obtain some relevant meaning (Jylhä & Suvanto, 2015). Data, on the other hand, is considered to be symbols, images, text or sound that does not possess, explicitly, meaning until processed (Jylhä & Suvanto, 2015;

Sebastian-Coleman, 2013; Slone, 2006). Based on these propositions, Jylhä & Suvanto, (2015), posits that poor quality of information has a negative impact on value creating processes because relevant meaning cannot be extracted. As such actions based on poor information are considered to be wrong (Jylhä & Suvanto, 2015). Analysing the quality of information is then considered to be a crucial activity to estimate the value information provides to users (Levis et al., 2007).

It has been noted that the value of information provided is contextual i.e. depends on the users situation or problem to be solved (Sebastian-Coleman, 2013). As indicated by Sebastian-Coleman, (2013), poor quality of information possess the ability to cause wasteful processing activity whereby changing the value of the information to negative. In FM, Jylhä & Suvanto, (2015) identified three drivers of waste that were as a result of information. These include:

1. Over-dissemination of information
2. Deficient information quality
3. Ineffective communication

However, other causes of waste attributed to information quality have been elucidated by Hicks, (2007) and Hicks, Culley, & McMahon, (2006). These have been described in Table 2:2:

Table 2:2 Cause of Waste due to IQ Adapted From Hicks, Culley, & Mcmahon, 2006; Hicks, 2007

	Cause of Waste	Waste Attribute
1	Information that cannot flow because it has not been generated, a process is broken, or a critical process is unavailable	Over-Processing
2	Information is unusable to flow because it cannot be identified and flow activated or shared processes are incompatible	Waiting
3	Excessive information is generated and maintained or excessive information flow. As a consequence, the most appropriate and accurate information cannot be easily identified	Over Production
4	Inaccurate information flow resulting in inappropriate downstream activities corrective action or verification	Defects

At this juncture, it is important to understand the concept of quality. The following section provides an overview of quality where the meaning of quality will be discussed. In addition, details of the relationship of quality and cost will be examined due to the inextricable link between them. Finally, understanding the nature of poor quality through the lens of quality gap will be discussed.

2.9 Theory of Quality

Quality has predominantly been associated with manufacturing but has also come to be associated with the service industry (Mishra & Sandilya, 2009). According to Mishra & Sandilya, (2009) quality has undergone considerable conceptual change to include process control, quality assurance, total quality management, and strategic quality management. The quality characteristics of a product embraces the form, fit, and function attributes relative to its purpose (Hoyle, 2007). Hoyle, (2007) argues that such attributes are very subjective, and not precisely measured other than by observation and comparison by human senses. Mishra & Sandilya, (2009) elaborated on this by indicating that quality depends upon the perception of a person in a given situation and can be user-oriented, cost-oriented, or supplier-oriented. To the end, quality has taken on various meanings and has been associated with fitness for purpose, conformance to requirements, characteristics, and degree of the preference (Mishra & Sandilya, 2009). The subsection below provides a view of definitions attributed to quality from the perspective of different authors.

2.9.1 Definition of Quality

Hoyle, (2007) defines quality as the degree to which a set of inherent characteristics, to which quality is attributed, fulfils a need, or expectation stated, generally implied, or obligatory. These characteristics have been divided into product quality characteristics and service quality characteristics (Table 2:3). According to Hoyle, (2007), when the value of these characteristics are quantified or qualified, they are termed product requirements. This expresses the needs or expectations that are intended to be fulfilled by a process output (Hoyle, 2007).

Table 2:3 Attributes Associated with Product and Services (Hoyle, 2007)

Product quality characteristics		
Accessibility	Functionality	Size
Availability	Interchangeability	Susceptibility
Appearance	Maintainability	Storability
Adaptability	Odour	Strength
Cleanliness	Operability	Taste
Consumption	Portability	Testability
Durability	Producibility	Traceability
Disposability	Reliability	Toxicity
Emissivity	Reparability	Transportability
Flammability	Safety	Vulnerability
Flexibility	Security	Weight
Service quality characteristics		
Accessibility	Credibility	Integrity
Accuracy	Dependability	Promptness Responsiveness
Courtesy	Efficiency	Reliability
Comfort	Effectiveness	Security
Competence	Flexibility	

Mishra & Sandilya, (2009) defines quality as fitness for use at the most economical level. Mishra & Sandilya, (2009) further states the quality of a product or service is its ability to ensure complete customer satisfaction. Juran & Godfrey, (1999) refers to quality as those features of products, which meets customer needs and thereby provide customer satisfaction. Within this context, Juran & Godfrey, (1999) argues that quality is income oriented, the purpose of which to provide greater customer satisfaction. A second definition put forward by Juran & Godfrey, (1999) states that quality means freedom from deficiencies which causes rework, failures, and dissatisfaction. In this context, quality is oriented to cost (Juran & Godfrey, 1999).

In the seminal work of Parasuraman, Zeithaml, & Berry, (1988), the concept of quality was defined from the perspective of perceived quality. In the authors opinion, quality is the consumer's judgement about an entity's overall excellence or superiority resulting from a comparison of expectation with perceptions of performance (Parasuraman et al., 1988). According to Parasuraman et al., (1988) this definition of quality encapsulates a subjective (humanistic) approach to quality determination. Hoyle, (2007) supports this assertion by stating consumers express a relative satisfaction to product or services and use subjective terms in assessing quality. Thus measures of quality are subjective and enable consumers rate products and services according to the extent to which they satisfy their requirements (Hoyle, 2007; Parasuraman et al., 1988).

On the contrary, Mishra & Sandilya, (2009), noted that other classes of products, such as engineering products, can be measured in terms of characteristics that contributes to the overall performance of the product i.e. performance characteristics. Parasuraman et al., (1988) terms this as objective quality. Mishra & Sandilya, (2009) classifies these performance characteristics as; continuous, discrete, and binary and explains them as follows:

1. Continuous: this may take any value within a given range
2. Discrete: this is related to appearance or aesthetics and are subjective
3. Binary: this yields two distinct results i.e. yes or no, 0 or 1

2.9.2 Quality and Cost Relationship

It is worthy to note here that Juran & Godfrey, (1999) draws a parallel between income and cost of quality. These are functions that have its origins in economics, but Hoyle, (2007) attempts to provide direct links with quality. According to Hoyle, (2007) the criteria that determine the saleability of a product or service are price, quality and delivery. Price is a function of cost, profit margin, and market forces (Perman & Scouller, 2004). Hoyle, (2007) argues that price is a transient feature of a product, but quality possesses more permanence in the effect it produces. Hoyle, (2007), as an addendum, notes that consumers utilise price as a method of comparison when determining the quality of product or services i.e. high prices indicates good quality characteristics and vice versa. However, Perman & Scouller, (2004) indicated that the price of products is subject to economic forces of demand and supply, for instance, when certain products are scarce, the price tends to rise and vice versa. Therefore, price is neither an inherent nor permanent quality feature or characteristics, but negotiated and varies without any change to the inherent characteristics of the product (Hoyle, 2007).

The attainment of quality has costs attributed to it. This acts as a means to quantify the total cost of quality-related efforts and deficiencies (Mauch, 2009). However, there have been limited application of concept of costs in quality management (Campanella, 1999; Mauch, 2009; Schiffauerova & Thomson, 2006). Mishra & Sandilya, (2009) noted a proportionality between cost and quality. They are complementary and not conflicting objectives (Campanella, 1999) and attempts to improve quality must take into consideration the cost associated with achieving quality (Schiffauerova & Thomson, 2006). As such, by classifying quality-related actions, managers are able to evaluate investments in quality based activities by describing the monetary benefits and ramification of proposed changes (Campanella, 1999; Mauch, 2009).

Within this context, Hoyle, (2007) classifies costs associated with quality as avoidable cost and unavoidable cost. In this regard, Hoyle, (2007) argues that cost associated with quality is a result of variations that exceeds the tolerable limits within a processes[3]. Schiffauerova & Thomson, (2006) however states that cost of quality is the sum of conformance plus non-conformance costs. According to Schiffauerova & Thomson, (2006) conformance cost is the price paid for the prevention of poor quality, and non-conformance cost is the cost of poor quality caused by product or service failure. Mishra & Sandilya, (2009) lists quality cost as follows:

1. Prevention cost: cost associated with designing, implementing, and maintaining quality system with the aim of minimising failure
2. Appraisal cost: cost incurred for auditing service procedures to ensure conformance to standards and requirements
3. Internal failure cost: costs incurred due to defects that results in failure to meet the quality requirements
4. External cost: cost incurred as a liability for defects

These costs have been grouped into categories by Mishra & Sandilya, (2009) and are presented in Table 2:4

[3] All processes has an element of variation (Hoyle, 2007)

Table 2:4 Categories of Cost as Described by Mishra & Sandilya, (2009)

Category	Attributes
Cost to Control Quality	
Prevention cost	1. Cost of quality planning 2. Cost of documenting 3. Process control costs 4. Cost of personnel training 5. Cost associated with preventing recurring costs 6. Cost of investigation and research into correction of defects
Appraisal cost	1. Process capability measurement 2. Testing and inspection cost 3. In-process or final inspection and test cost 4. Maintenance and recalibration cost 5. Audits and review costs
Cost of Failure to Control Quality	
Internal failure cost	1. Cost associated with scrap 2. Redesign cost or re-work cost 3. Cost of reinspection and retest 4. Cost due to sale of defective items 5. Cost of delays and penalties 6. Cost of administrative time
External cost	1. Warranty cost 2. Product liability 3. Cost of inspecting and repairing defects 4. Cost of replacement

2.9.3 Understanding Poor Quality (Quality Gap)

As implied from the preceding sections, product or services need not possess a defect for it to the considered as poor quality i.e. it may not possess the attributes that would be expected (Hoyle, 2007). Poor quality may be defined as a failure of product or service to perform intended operation successfully (Mishra & Sandilya, 2009). In this regard, such product or service is lacking features that do not conform to consumers' acceptable requirements. To this end, Hoyle, (2007) posits that a precise means of measuring quality is needed for organisation producing product or services, regardless of type or class.

A significant challenge experienced in quality management lies in understanding quality gaps and their effect resulting in poor quality. The difference between customer expectations and how quality is assessed is reflected by the quality gap (Miller, 2005). Tucker & Pitt, (2009) further stressed that service quality fails when there is a gap between service expectations and perceptions because of shortfalls in the organisation.

According to Juran & Godfrey, (1999) the gaps in quality experienced by stakeholders are the compound result of smaller gaps which are understanding gap, design gap, process gap, operations gap, and perception gap, as expressed in the shortfalls of the organisation (Figure 2:9 and Table 2:5).

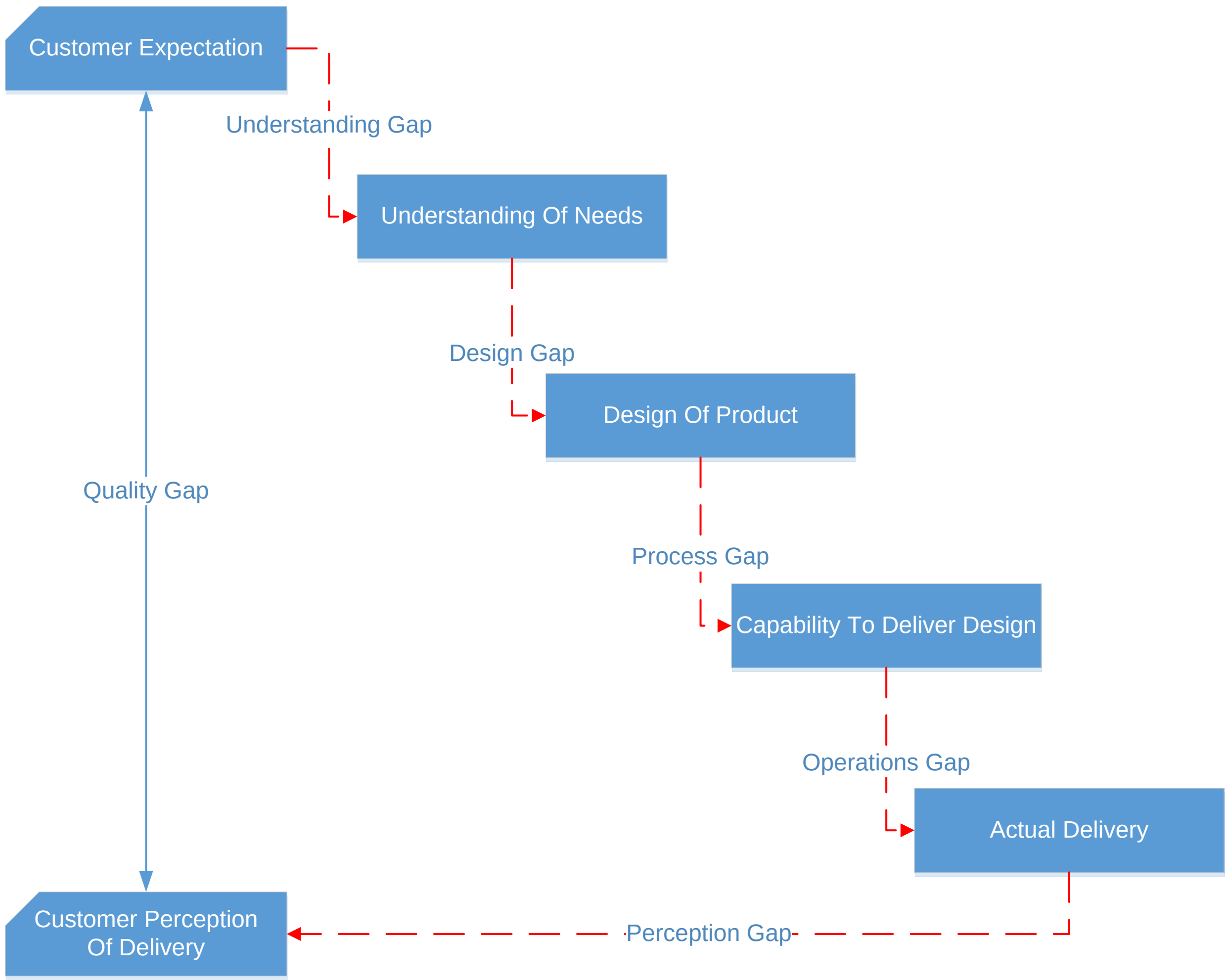


Figure 2:9 Quality Gaps and Its Constituent Gaps Adapted From Juran & Godfrey, (1999)

Table 2:5 Explanation of the Quality Gaps Adapted From Juran & Godfrey, (1999)

Gap	Explanation
Understanding Gap	Expresses as a lack to consider the customer and their needs due to erroneous confidence in organisation ability to understand customer needs
Design Gap	Arises as a result of isolation between designers of products or services and the techniques or disciplines used in understanding customer needs
Process Gap	Processes used in delivering products or services are not consistent over time or the lack of process capability
Operations Gap	The means by which the processes is operated and controlled may create additional deficiencies in service delivery
Perception Gap	Arises from a failure to understand the customer and their needs

Hoyle, (2007) specifies that as quality implies the extent or degree to which a requirement is met, several techniques thus serves the purpose of enabling the organisation to close the gap between the standard required and the standard reached (Figure 2:10). A widely used technique is the SERVQUAL[4] framework developed by Parasuraman, Zeithaml, & Berry, (1988). This is a 22-item instrument for assessing customer perceptions of quality (Parasuraman et al., 1988). This approach has been adopted in measuring quality of information and its ancillary technology (Blattmann, Kaltenrieder, Haupt, Myrach, & Thomas Myrach, 2002; Jiang, Klein, & Crampton, 2000; Philip & Hazlett, 2001) but has been met with strong criticisms (Asubonteng, McCleary, & Swan, 1996; Buttle, 1996; Dyke, Kappelman, & Prybutok, 1997). The succeeding section shall explore the issue of IQ within the focus of quality.

[4] SERVQUAL: Service Quality

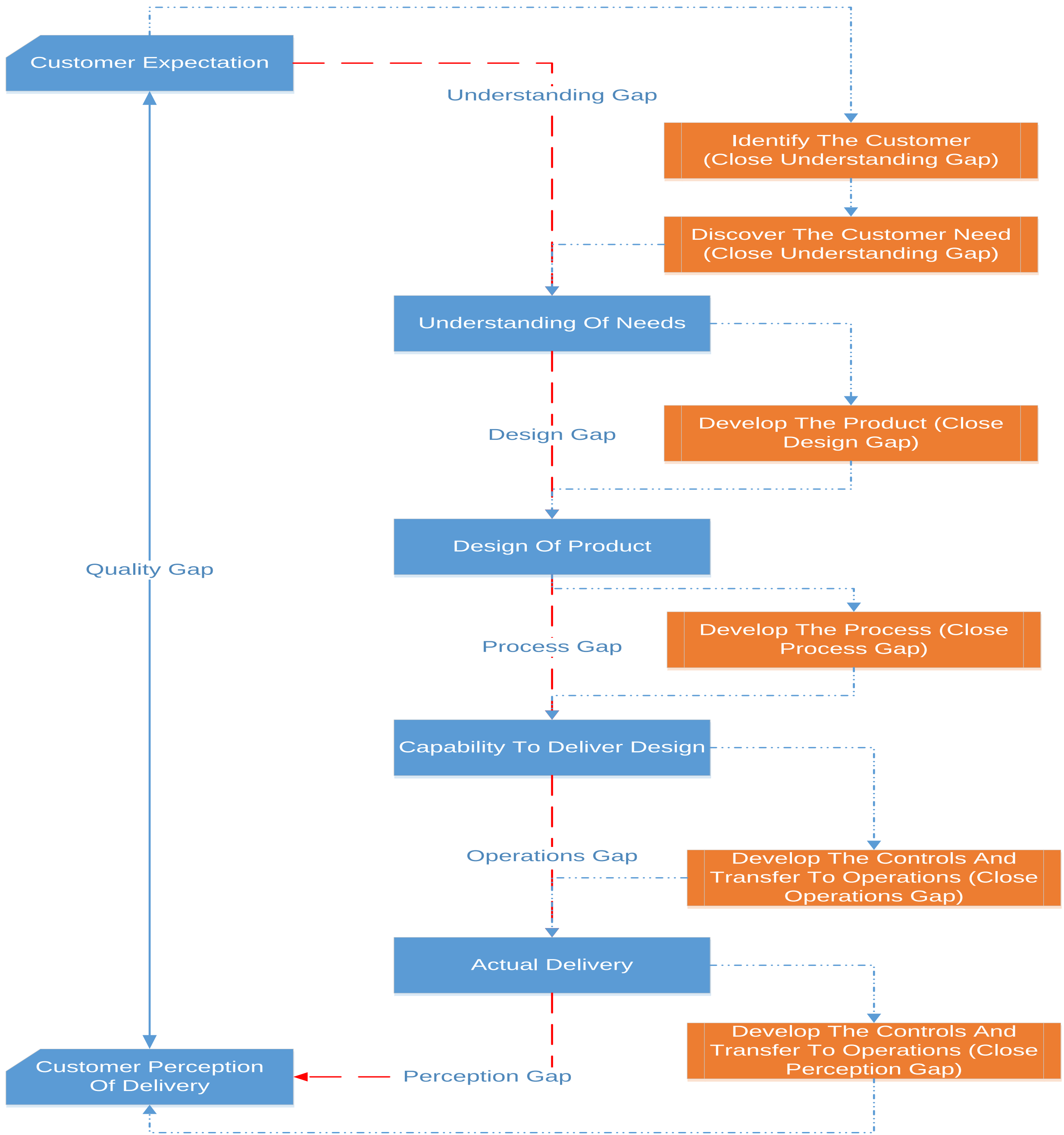


Figure 2:10 Approach to Closing the Quality Gaps (Hoyle, 2007)

2.10 Theory of Information Quality

It is pertinent to lay the foundation in this research a theory of IQ that facilitates and justifies the methodological principles used and the collection of relevant data for analysis. The precursor to IQ theory is information theory first conceptualised by SHANNON, (1948), in his seminal work on the Mathematical Theory of Communication. SHANNON, (1948), aim in this work was to solve the technical problem of noise in the communicated information through telecommunication lines. In this context SHANNON, (1948), described the fundamental engineering problem of the reproduction of a message in telecommunication when it is transmitted from one place to another without consideration of the meaning of the message (Grenn, 2014). The exclusion of meaning within this context was deemed legitimate, as the problem at hand was the issue of transmitting information efficiently through telegraph lines as seen from the quote:

> *"…The fundamental problem of communication is that of reproducing at one point either exactly or approximately a message selected at another point. Frequently the messages have meaning; that is they refer to or are correlated according to some system with certain physical or conceptual entities. These semantic aspects of communication are irrelevant to the engineering problem. The significant aspect is that the actual message is one selected from a set of possible messages. The system must be designed to operate for each possible selection, not just the one which will actually be chosen since this is unknown at the time of design…"* (SHANNON, 1948)

The exclusion of meaning based on SHANNON, (1948) postulation does not diminish the importance of the theory but rather lays a solid foundation for the development of a theory of IQ. In this regard, Grenn, (2014) posits that the theory of IQ is concerned with the development of the message in the form of a set of requirements and the number of possible quality distributions available for message. From the theory, it can be observed that information encompasses a message premised on a set prerequisite, which considers a set of quality attributes that ensures the information is useful and fit for purpose. In this regard, research in IQ has considered information to be products from a processing activity that actively converts raw materials to finished products (Koronios et al., 2005; S. Lin et al., 2007; Wang, R. Y., Lee, Y., Pipino, L., Strong, 1998).

This parallels the manufacturing process and hence the outputs are known as information products (Al-Hakim, 2006).

In IQ research, data is considered as the raw material while information the finished product. In order to understand these concepts appropriately, the definition of data and information must be outlined. According to Al-Hakim, (2006) data is an item about things, events, activities, and transactions that are recorded and stored but not organised to convey any specific meaning. Information, on the contrary, is data that have been organised in a manner that gives them meaning for the recipient (Al-Hakim, 2006; Sebastian-Coleman, 2013). From this definition, it can be seen that what separates data from information is “meaning” which each conveys to the recipient. The use of information and data has been applied interchangeably in research focusing on IQ (Baškarada & Koronios, 2014; Levis et al., 2007; Pipino et al., 2002). However, for the purpose of this study, a clear demarcation between data and information is drawn, and the use of the term information will be adopted predominantly.

IQ is a multi-dimensional concept representing the fitness for use of information (Borek et al., 2014). Batini & Scannapieco, (2006) highlighted the importance of the multi-dimensional construct of information to characterise its quality. According to Sebastian-Coleman, (2013) IQ is defined by two related factors: (1) how well it meets the expectations of consumers i.e. how well it is able to serve the purpose of its intended use or uses; and (2) how well it represents the objects, events and concepts it is created to represent. Expectations are usually equated with requirements of particular users and need to be defined accordingly (Sebastian-Coleman, 2013). Haug, Arlbjørn, Zachariassen, & Schlichter, (2013) provides a generally accepted definition of IQ as “fitness for use”. However, Haug et al., (2013) accepts that further definition of IQ exist when viewed from a dimension context (Batini et al., 2009; Wand & Wang, 1996; R. W. Wang, Strong, Richard, & Diane, 1996). Based on this, IQ is context dependent and vary from one purpose to another (Woodall et al., 2012). Therefore to measure IQ in a practical way, it essence is defined along different dimensions within the context it operates in (Woodall et al., 2012).

Different IQ dimension have been identified and defined by different authors, but the most cited form of IQ dimension are accuracy, reliability, timeliness, relevance, completeness, currency and consistency (Chaffey & Wood, 2005; Haug et al., 2013). Though concepts and dimensions to IQ have been established, defining how to measure and monitor the quality of information, especially as its use and the amount evolve over time, presents a significant challenge. Sebastian-Coleman, (2013) highlights two prominent factors that contribute to this:

1. Deficiency in tools for measuring basic quality of information
2. Non-existence consensus on what those tools should be

Another noted problem of measuring IQ is one of how to measure an abstract concept (Batini et al., 2009). For this to be effective, people need to understand what they represent and why they are important. Measurement involves a comparison between the thing being measured and the object against which it is measured (Sebastian-Coleman, 2013). To this end, IQ is measured against some form of expectation – dimensions – about the condition of information as defined by consumers (Sebastian-Coleman, 2013). This is discussed in the subsequent section.

2.10.1 Information Quality Dimensions

It has been noted that there is no general agreement of the dimensions of IQ (Batini et al., 2009; S. Lin et al., 2006; Sebastian-Coleman, 2013; Wand & Wang, 1996). R. W. Wang et al., (1996) defines IQ dimensions as a set of IQ attributes that represents a single aspect or construct of IQ. Sebastian-Coleman, (2013) defines IQ dimension as those aspects of data that can be measured and through which its quality can be quantified. Koronios et al. (2005) argues that though IQ has been described from the perspective of accuracy, this provides a limited contextualization of the issues in IQ. Lin et al., (2007) suggested that IQ should be defined beyond accuracy and encompassing multiple dimensions. However, this may prove more difficult due to the nature of different data environment (S. Lin et al., 2007). A typical understanding of IQ is information fit for use by the information consumer. Albeit simplistic, it provides a crucial foundation for the understanding of IQ. Thus, to determine the dimension of the quality of information, a contextual view has to be established. This view takes into account the type of information consumer and the operations or activities performed by the information consumer. By so doing, a vivid and explainable construct of IQ dimension can be determined.

According to R. W. Wang et al., (1996) IQ problem go beyond accuracy to include other aspect such as completeness and accessibility. R. W. Wang et al., (1996) noted that to improve IQ an understanding of the construct from an information consumer perspective is important. In the study carried out by Richard Y Wang et al., (1995) the dimensions of IQ were provided as well as the definitions (Table 2:6).

Table 2:6 Dimension and Definitions of Information Quality (Source: Richard Y Wang et al., 1995)

DIMENSIONS	DEFINITIONS
Accuracy	The recorded value is in conformity with the actual value
Timeliness	The recorded value is not out of date
Completeness	All values for a certain variable are recorded
Consistency	The representation of the data value is the same in all cases

R. W. Wang et al., (1996) developed a framework that captures the characteristics of IQ that are important to information consumer (Figure 2:11).

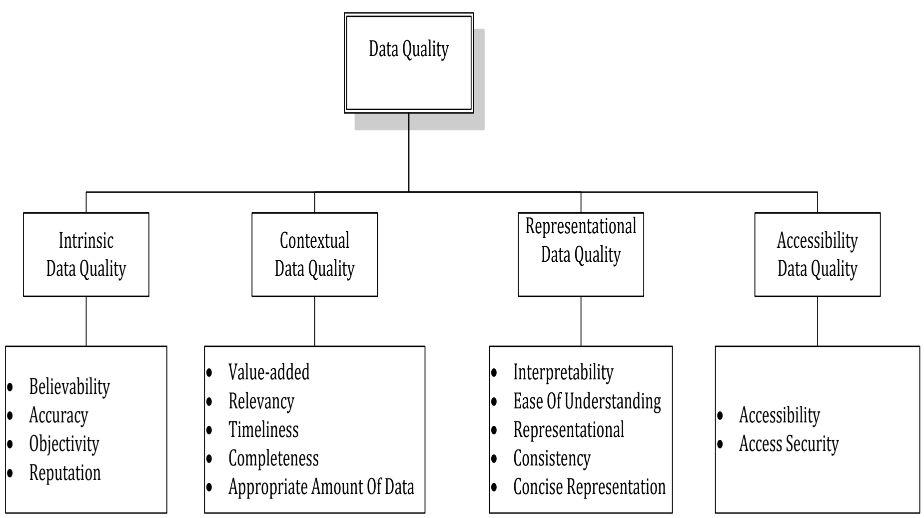


Figure 2:11 Framework of Information Quality (Source R. W. Wang et al., 1996)

Cai & Zhu, (2015) produced a framework for assessing IQ in which the following dimensions were suggested: availability, usability, reliability, relevance, and presentation. R.Y. Wang et al., (1993) provides IQ dimension as accuracy, timeliness and completeness. Koronios et al. (2005) elucidated the dimensions of IQ to include accuracy, reliability, importance, consistency, precision, timeliness, fineness, understandability, conciseness, and usefulness. Laudon, (1986) listed IQ dimensions as completeness, accuracy, and ambiguity. Lin et al., (2007) narrowed this down to accuracy, completeness, timeliness, and consistency. Jylhä & Suvanto, (2015) highlighted the following dimension to IQ as accessibility, contents, availability, timeliness, validity, effectiveness, and cost. Herrala, (2007) goes further to provide a list of attributes based on aggregated information (Table 2:7).

Table 2:7 Contextual meaning of IQ Attribute (Source: Herrala, 2007)

s/n	IQ attribute	Contextual meaning
1	Accuracy	1. The quality of being near to the true value 2. The number of significant characters given in a string 3. The information are certified error free and flawless
2	Clarity	1. The quality of being free from obscurity and easy to understand; the comprehensibility of clear expression 2. Clear or distinct to the view of the user, the mind and conveying the meaning clearly and simply 3. Easily and clearly understood
3	Comparability	1. Qualities that are comparable
4	Completeness	1. The state of being complete and entire; having everything that is needed 2. There is enough breadth, depth and scope of information for decision making, completely containing all the elements is needs to have, information added to complete or make up a deficiency
5	Conciseness	1. Expressing much in few information 2. Concise representation: well-presented and organised
6	Consistency	1. A harmonious uniformity or agreement among things or parts 2. Logical coherence and accordance with the facts 3. Information constantly adhering to the same principles, course, form, devoid of gaps in transmission or frequency, consistent; identical or consistent, as from example to example, place to place, or moment to moment: without variations in detail
7	Content	1. Satisfied or showing satisfaction with things 2. Completely containing all the elements is needs to have
8	Currency	1. The property of belonging to the present time 2. Age of the information. Arrives at the right time 3. Used for the study of a phenomenon as it changes through time
9	Efficiency	1. Skillfulness in avoiding wasted time and effort 2. Information is designed or arranged to offer the least resistant and made efficient and compact by stripping off nonessentials

		3. Ease of inspection or examination of information and its facility to evaluate or improve its appropriateness, safety, efficiency, or the like
10	Flexibility	1. The quality of being adaptable or variable. 2. Easily adaptable 3. The property of being flexible; easily bent or shaped
11	Format	1. The organisation of information according to preset specifications
12	Freedom From Bias	1. The information is unbiased and non-subjective
13	Importance	1. Of great significance or value 2. The information is relevant, applicable and usable to the operations
14	Informativeness	1. Tending to increase knowledge or dissipate ignorance
15	Interpretability	1. Capable of being understood
16	Level Of Detail	1. A small part that can be considered separately from the whole 2. Highly detailed; having many small and distinct parts useful for detailed information analysis and information mining for decision-making
17	Precision	1. The quality of being reproducible in amount or performance
18	Quantitativeness	1. Expressible as a quantity or relating to or susceptible of measurement
19	Relevance	1. The information is relevant, applicable and usable to the operations 2. Having a bearing on or connection with the subject at issue
20	Reliability	1. The quality of being dependable or reliable
21	Scope	1. An area in which something acts, operates, has power, or control for decision-making
22	Sufficiency	1. Information is adequate for the purpose, activity or function; sufficient for the purpose and as much as necessary
23	Timeliness	1. Being at the right time
24	Understandability	1. Know and comprehend the nature or meaning of, to perceive the meaning of; grasp the idea of; comprehend
25	Usable	1. The quality of being able to provide good service
26	Usefulness	1. The quality of being of practical use

The limitations of these studies in determining the dimension of IQ is the adoption of an intuitive approach which is based on the researchers experience or instinctive understanding of what IQ attributes are important thereby resulting in a small set of quality attributes being identified and investigated (R. W. Wang et al., 1996). This approach thus leads to IQ treated as an intrinsic concept independent of the context in which it is produced and used (Strong, Lee, & Wang, 1997). It fails to provide a close approximation of the dimensions of IQ based on the operation performed by the actors within an organisation. It is, therefore, important to (1) determine what attributes are associated with IQ , and (2) assess the relative importance of these attributes from the perception of the information consumer within the context of the operations performed in order to define the dimensions these attribute belong to.

2.10.2 Factors Influencing Information Quality

Haug, Arlbjørn, Zachariassen, & Schlichter, (2013) provided an empirical study on the barriers to IQ and noted that poor IQ had an effect on many other facet of the organisation i.e. business users, customer and customer satisfaction, increased operation costs, inefficient decision making processes, lowered employee job satisfaction, organisation culture, trust and acceptance. This has been corroborated by Redman, (1998) who goes further to break this down to the different levels of the organisation i.e. strategic, tactical, and operational levels. In essence, Redman, (1998) acknowledges the fact that the quality of information has an effect on the individual levels of the organisation. However, this does not provided evidence if the structure of the organisation has an effect on the quality of information.

Lin et al., (2006) presents a study investigating IQ in AM organisation from the technology, organisational, and people perspective. Initial finding from the study indicated that numerous factors affect the quality of information (Table 2:8). A significant limitation to this study was the copious amount of variables considered. This resulted in limited relevance to the significance of the result. In addition, the study considered neither the structure nor size of the organisation involved in the research, as this might have had an influence to the observed outcome.

Table 2:8 Factors Influencing Information Quality in Asset management (S. Lin et al., 2006)

Perspective	Factor	Explanation
Technology	System Integration	There is limited Integration between business systems and technical systems leading to island of information. The makes it difficult to bring real-time information from the site into the business systems to facilitate data driven decision-making
	Data Access	There is a gap between the user and maker of the asset. Thus information is not passed on to the user of the asset in a usable format or does not conform to the physical asset delivered
	Database Synchronization	There is limited capability in enterprise asset management system synchronisation that provides the ability to assess, use, display and manage information effectively due to lack of business and workflow rules
	Data Exchange	There is limited data exchange between asset management applications for seamless access to information across heterogeneous systems and different departments within the enterprise
	Data Collection Process	The process of data collection is time-consuming, due to the manual approach adopted, and organisation have concluded the information collected this is not worth the money
	Coding of Information	There are discrepancies between coding of information from one database to another making difficult to compare data from different sources
	Information Technology	There is significant complexity in setting up operational databases due to numerous specification
	Extraction of Data	Different users of operational databases have different needs which leads to difficulty in setting up databases for efficient extraction of information
Organisational	Organizational Readiness and Business Process Reengineering	The Implementation of technical systems involves broad organisational transformation processes, with significant implications to the organisation's asset management model, organisation structure, management style and culture, and people. This demands an organisation being prepared – organisational readiness. Organisational readiness is described as having the right people, focused on the right things, at the right time, with the right tools, performing the right work, with the right attitude, creating the right results. It is a reflection of the organisation's culture. However, organisations experience implementation challenges because they are not ready for integration and significant conflict of interest
	Management Commitment	Management commitment to information quality is limited thus limited resources are allocated to address information quality challenges
	Lack of Codified Business Standard	Organisation don't have a set of standards for corporate information which makes information quality monitoring possible
	Disconnect between Business and IT	Disconnect between Business and IT while Creating Metrics for Monitoring

People	Training	People's skills and abilities to use the system efficiently are critical to ensure the quality of information in asset management systems. This skills are enhanced by training As such lack of training can may serious damage and have an adverse impact on information quality
	Data Recording	Effective data recording is achieved from personal factors, which include motivation and skill levels of the personnel. Where this is lacking, information provided will be of poor quality
	Communication and Management Feedback	People's problems, people's relationships, people's aspirations, and people's personal agendas are seldom given the consideration leading to poor communication and feedback. This culminate in poor quality of information provided

According to Haug et al., (2013) the challenge of IQ has been exacerbated by several issues. For instance information technology, having become an essential part of most companies helping in the collection of large volume of data has inadvertently created the problems of IQ (Haug et al., 2013). As such organisation assume that installing the latest software tool increases the quality of information but paradoxically often leads to the problem (Haug et al., 2013). Haug et al., (2013) further acknowledges that poor IQ in organisation is a multifaceted challenge caused by several quality barriers which have been classified into 12 types and grouped into 3 main categories (Table 2:9)

Table 2:9 Information Quality Barriers adapted from Haug et al., (2013)

S/N	Information quality Barrier	Category
1	Lack of IT systems for data management	Information Technology
2	Lack of possibilities for input in existing IT systems	
3	Poor usability of IT systems	
4	Lack of written information quality policies and procedures	Organisation Procedures/Policies
5	Lack of clarity of roles in relation to data creation, use and maintenance	
6	Inefficient organisational procedures	
7	Lack of management focus on relation to information quality	
8	Lack of information quality measurement	
9	Missing placement of responsibilities for specific types of data	People
10	Lack of reward/reprimand in relation to information quality	
11	Lack of training and education of data users	
12	Lack of emphasis on the importance of information quality from managers	

These barriers were applied in an empirical study within small, medium, and large organisations. It was observed by Haug et al., (2013) that the issue of IQ barriers was of similar importance in either category of organisation studied (Figure 2:12), but the significance of the issue increased as the size of the organisation increased. A significant limitation of this study was the fact it did not consider the structure of the organisation as a variable investigated. However, the study highlighted a major challenge of IQ research being the contextual nature of each identified barrier.

Contextualisation[5] in IQ research presents a challenge in interpretation and generalisation outcomes of studies (Batini et al., 2009) and this is evidenced in the study conducted by Haug et al., (2013).

As noted from the preceding discussions, the structure of the organisation had not been considered as a factor that might influence the quality of information within an organisation. Mintzberg, (1979) defines the structure of an organisation as the sum total of the ways in which it divides its labour into distinct tasks and then achieves coordination among them. Huczynski & Buchanan, (2000) adds to this and explains that organisation structure constitutes a system of arrangements and work patterns between the various positions and their holders. In this vein, organisation structure has been argued to have an effect on the quality of information (Jordan, 1994; Jordan & Tricker, 1995; Mintzberg, 1979; WILLMER, 1977). For instance, WILLMER, (1977) argued that as the organisation becomes more complex and elaborate, the more unreliable the information.

[5] Contextualization: The act of placing a concept, word, event, or perspective in a specific context.

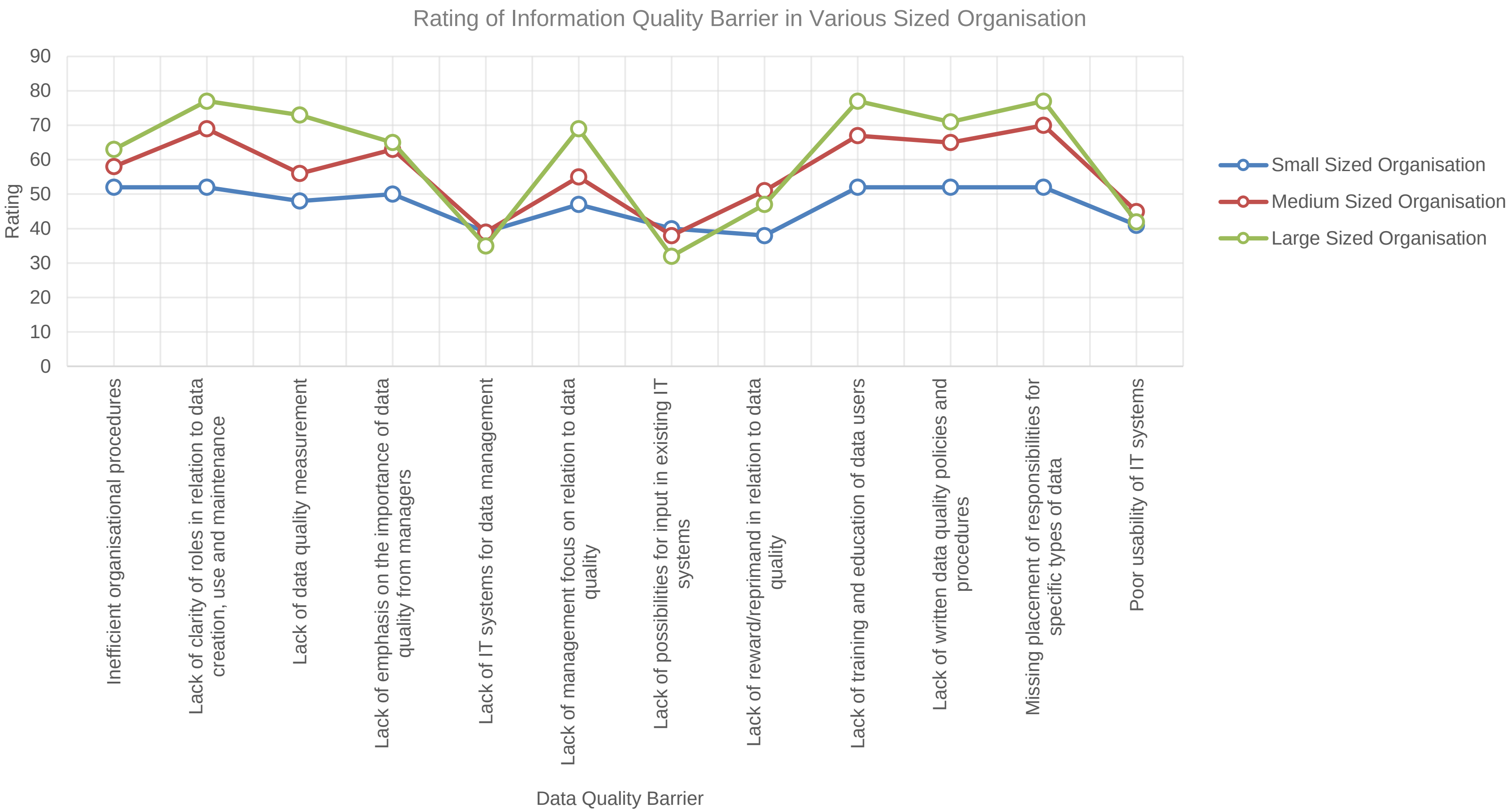


Figure 2:12 Information quality Barrier Ratings adapted from Haug et al., (2013)

2.11 Methodologies for Assessing Information Quality

As information evolve and become more complex, the techniques required to assess and improve its quality become varied. However, without the ability to assess the quality of information, organisations are unable to assess the status of their organisational performance (Y. W. Lee, Strong, Kahn, & Wang, 2002). Batini et al., (2009) provides a systematic and comparative description of methodologies used in IQ research. These methodologies are diverse and vary in complexity with special areas of application. For instance Batini et al., (2009) listed examples which include record linkages, business rules, and similarity measures. However, these methodologies have been unable to enhance the quality of information used in AM (S. H. Lee & A. Haider, 2014).

Batini, Cabitza, Cappiello, Francalanci, & di Milano, (2007) indicates that methodologies can either be: (1) general purpose encompassing a wide range of phases and quality dimensions and provide a number of domain-independent techniques, or (2) specialized which focus on specific quality tasks or on a specific application domain. Batini et al., (2009) defines IQ methodology as a set of guidelines and techniques that defines that rational process to assess and improve the quality of information, starting from input information within a given application context. In contrast to this, Woodall et al., (2012), provides an alternative definition which views this as a function that leads an organisation to improve IQ by implementing processes to measure, assess cost of, improve and control IQ by providing guidelines, policies, and education for IQ improvement. The ultimate goal is to increase organisational efficiency by eliminating the cost of poor quality of information (Woodall et al., 2012). This has led to the definition of methodologies that help to select, customise, and apply IQ assessment and improvement procedures. A summary description of some of these methodologies is presented in the following sections.

2.11.1 Total Information Quality Management Methodology (TIQM)

Total information quality management (TIQM) has been designed as a tool for organisational managers in assessing IQ (Batini et al., 2007). The concept of TIQM emanates from total quality management (TQM) philosophy (Baškarada & Koronios, 2014). TQM has been defined as a *"…set of systematic activities carried out by the entire organisation to effectively and efficiently achieve company objectives to provide product and services with a level of quality that satisfies customers, at the appropriate time and price…"* (Baškarada & Koronios, 2014).

TIQM demands a holistic, integrated approach based on four core elements, audit, clean, prevention, and compliance (Marsh, 2005). The premise of this methodology is quality activities must be an ongoing, active, preventative process and not a retrospective corrective activity (Marsh, 2005). TIQM main contribution are a set of specific techniques for cost-benefit analysis and a general managerial perspective (Batini et al., 2007). Wang, (1998) adapted a TIQM approach which considered the definition, measurement, analysis, and improvement of information quality. Wang, (1998) considered information quality as analogous to product quality whereby information product (IP) is the output from any business operation. The aim of TIQM as mentioned in Wang, (1998) is to deliver high-quality IP to information consumers by facilitating the implementation of an organisation overall IQ policy. Wang, (1998) argued that quality issues in product manufacturing are analogous to quality issues in information manufacturing (Table 2:10)

Table 2:10 Product vs. Information Manufacturing

Activity	Product manufacturing	Information manufacturing
Input	Raw materials	Raw data
Process	Assembly line	Information system
Output	Physical products	Information product

Thus the premise that organisation must treat information as a product that moves through an information manufacturing system much like physical produce is the fundamental of the methodology (Richard Y Wang, 1998).

According to Wang, (1998) information manufacturing can be viewed as a processing system that acts on raw data to produce information products. The rationale for developing the TIQM methodology as argued by Wang, (1998) suggests that such methodology must be discipline based and rigorous so that they can repeatedly be tested and employed by others while introducing applicable concepts that capture pertinent ideas in different operational environments. The concept underpinning TIQM include (Richard Y Wang, 1998):

1. A cycle of define, measure, analyse and improve, which has been adapted from the Deming cycle
2. An information manufacturing system that produces information products (IP) of which four roles have been identified
    a. information suppliers
    b. information manufacturers
    c. information consumers
    d. information product managers
3. Information quality (IQ) which consists of quality dimensions which have been grouped into categories (Table 2:11)

Table 2:11 Information Quality Categories and Dimensions

IQ Category	IQ Dimension
Intrinsic IQ	Accuracy, Objectivity, Believability, Reputation
Accessibility IQ	Access, Security
Contextual IQ	Relevancy, Value-Added, Timeliness, Completeness, Amount of Data
Representational IQ	Interpretability, Ease of Understanding, Concise Representation, Consistent Representation

According to Wang, (1998), the tasks embedded in TIQM are performed in an iterative manner. In applying TIQM, practitioners must first define the characteristics of the IP, assess the IP's IQ requirement and identify the information manufacturing system for the IP (Richard Y Wang, 1998). Wang, (1998) however acknowledged that these tasks can be challenging for organisation.

2.11.2 Information Quality Assessment Framework (IQAF)

Pipino, Lee, & Wang, (2002) stated a need for obtaining usable IQ metrics in determining how good an organisation IQ is. However, Pipino et al., (2002) also acknowledged that useful metrics are lacking in practice. This presents a significant challenge to ascertaining IQ in organisation. Also, as the multi-dimensional nature of IQ increases so also does the complexity of measurement (Pipino et al., 2002). In an attempt to solve this problem, Pipino et al., (2002) suggested that companies must deal with both the subjective and the objective perception of the individual involved with the information measurement. According to Pipino et al., (2002) subjective IQ assessment reflects the needs and experience of stakeholders i.e. data collectors, custodians, data consumers and data managers. If the assessment of IQ is considered poor, stakeholder's behaviour will be influenced by such assessment (Pipino et al., 2002). To this end, Pipino et al., (2002) developed the information quality assessment framework (IQAF) to satisfy these observations.

Pipino et al., (2002) noted that an assessment of stakeholder's perception of IQ, using a questionnaire within this framework, requires a predetermined list of IQ attributes. The objective assessment of IQ as suggested by Pipino et al., (2002) can be divided into classes: (1) task-independent, and (2) task-dependent. Task-independent metrics reflects information without the contextual knowledge of the application which can be applied to any situation regardless of the task at hand (Pipino et al., 2002). Task-dependent metrics such as organisation business rules, company and government regulations, business constraints set by database administrator, are developed in specific application contexts (Pipino et al., 2002). Pipino et al., (2002) described three functional forms for developing an objective information quality metric for performing objective assessments. These include; (1) simple ratio, (2) Min or Max operation and (3) weighted Average.

1. Simple ratio measures the desired outcome to total outcomes (Pipino et al., 2002). This can be calculated by determining the number of undesirable

outcomes (UDO) divided by total outcomes (TO) subtracted from 1 (Equation 2:1) (Pipino et al., 2002).

$$\left({}^{\mathrm{UDO}}/_{\mathrm{TO}}\right) - 1$$

Equation 2:1 Simple Ratio

According to Pipino et al., (2002) the simple ratio values adheres to the convention that 1 represents the most desirable and 0 the least desirable score.

2. Min or Max Operation is used to handle dimension that require the aggregation of multiple IQ indicators (variables) which is computed from the normalised values of the individual quality indicators (Pipino et al., 2002). According to Pipino et al., (2002) the min operator assigns to the dimension an aggregate value no higher than the value of its weakest IQ indicator while the max operator is more useful in evaluating complex metrics when a liberal interpretation is warranted . These values are typically evaluated and normalised between 0 and 1 for individual IQ attribute (Pipino et al., 2002).
3. Weighted average is used in multivariate cases where there is a good understanding of the importance of each variable to the overall evaluation of a dimension. This requires the normalisation of the weighting factor to a value range of 0 to 1 for each variable rating.

Pipino et al., (2002) further suggested steps that may be adopted to improve organisational IQ, which incorporates both subjective assessment and objective assessment of IQ (Figure 2:13).

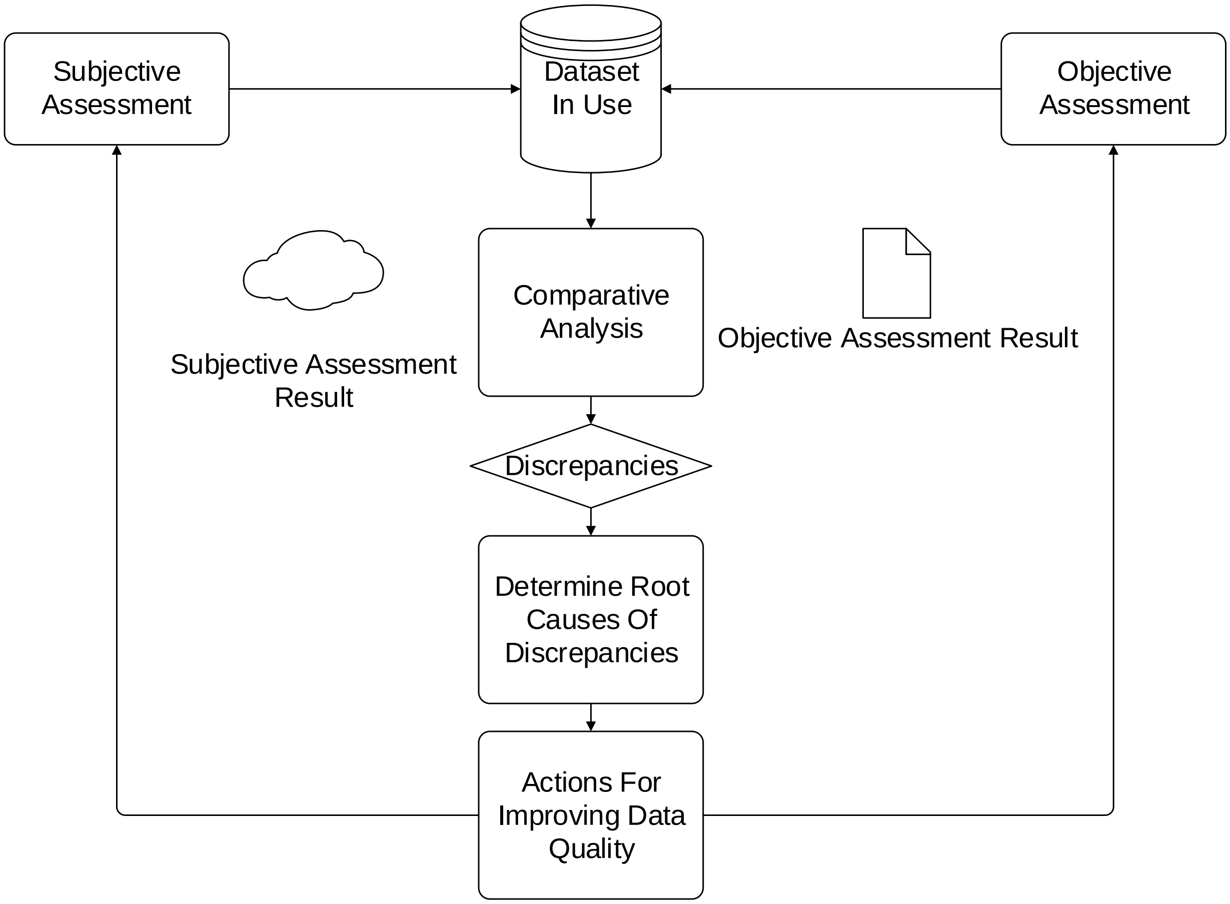


Figure 2:13 Information Quality Assessment adapted from Pipino et al., (2002)

2.11.3 The AIMQ Information Quality Assessment Methodology

The AIM Quality (AIMQ) methodology was developed by Lee et al., (2002) and encompasses a model of IQ, a questionnaire to measure IQ, and analysis techniques for interpreting IQ measures. It forms a basis for IQ assessment and benchmarking. Lee et al., (2002) argues that this constitutes an effective methodology for assessing IQ in various organisational settings where decisions are made to prioritise tasks and allocate resources for IQ improvement.

Batini et al., (2009) acknowledges AIMQ as an objective and domain independent technique for evaluating and improving IQ. According to Lee et al., (2002), the foundation of the AIMQ methodology is a model that consists of three parts:

1. The Product Service Performance/Information Quality (PSP/IQ) model: consolidates IQ dimensions into four quadrants: sound, dependable, useful, and usable information which represent aspects relevant to IQ improvement decisions
2. The Information Quality Assessment (IQA) instrument: measures information quality for each dimensions which are subsequently averaged to form measures for the four quadrants
3. The Information Quality Gap Analysis (IQGA) techniques: forms the basis for focusing IQ improvement by assessing the quality of an organisation's information for each of the four quadrants

2.11.4 Information Quality Management Capability Maturity Model (IQM-CMM)

Information Quality Management Capability Maturity Model (IQM-CMM) is a model adapted by Woodall et al., (2012) used in assessing and benchmarking levels of IQ management performance in AM organisations. The capability maturity model is based on the works of Paulk, Curtis, Chrissis, & Weber, (1993) who foremost adopted it in an attempt to improve the efficiency of information systems implementation. This has further been adapted and applied in the BE to improve productivity of construction project and FM processes (Amaratunga, Sarshar, & Baldry, 2002; SARSHAR et al., 2000).

Based on the concept developed by Woodall et al., (2012) the IQM-CMM constitutes an extensive set of process areas and critical success factors that are used as appraisal criteria for determining the level of maturity of an organisation when assessing IQ. The maturity level include optimising, managed, measuring, reactive, and chaotic where each process area is defined and contains a set of critical success factor (Woodall et al., 2012).

Though the model has been able to determine the maturity level of organisation in respect to IQ, the tool has been unable to provide a contextual identification of specific IQ dimension. In addition, the tool has been deemed too complex to implement and not able to determine an objective measure of information quality. Further limitations to the use of CMM have been highlighted by Alexander, (2008) and Amaratunga, Sarshar, et al., (2002) to include the inability of formulate and evaluate strategies and the inability to indicate best practice within an organisation context.

2.11.5 The Information Quality Grid (IQ Grid)

The final approach discussed to assess IQ in this thesis is the IQ grid conceptualised by Hostettler & Delez, (2006). According to the authors, this is positioned as a business-led approach for self-sustaining IQ. According to Hostettler & Delez, (2006) to goal of this tool is to act as a simple model to assess an organisation current position on IQ issues and provide a roadmap to sustainable IQ improvement. This approach is based on segmenting organisation IQ into quadrant along IQ awareness and IQ trend axis. According to Hostettler & Delez, (2006) the IQ awareness determines how well IQ is understood in the organisation while the IQ trend defines whether the IQ increases with time, decays, or remains stable. Hostettler & Delez, (2006) goes further to describe the elements of the quadrants and prescribe relevant actions that may be implemented to improve IQ. However, significant limitations to this method are as follows:

1. The methodology used in developing the tool is unexplained
2. There is a clear lack of IQ dimensions to be assessed
3. There is no clear measurement to indicate if the elements of the quadrants had been achieved

2.12 Chapter Summary

This chapter has provided a review of AM in FM and the effect IQ has on AM programs undertaken by FM organisations. The IQ literature presents evidence on the complexity and the impact of IQ on AM within FM. Likewise, with AM, several factors have been attributed to its critical success and failure. The literature review highlights the factors that are pertinent to the success of AM, which IQ has a direct effect on. These include planning, risk management, lifecycle management, financial and cost analysis.

From the review, it has been argued that AM operate within the remit of FM at the strategic level. Section 2.6 describes this relationship. In relation to this, FM success relies on its mode of service delivery and service management. In the study, the modes of delivery have been classified into three (3) parts (1) outsourcing, (2) in-house, and (3) mixed economy. Service management within these delivery modes include (1) risk management, (2) maintenance, and (3) FM helpdesk. IQ issues further affect the service management in FM. Therefore, to obtain the benefits of AM, it is important to ensure that IQ factors are sustained to high levels in the organisation which can provide accurate and effective analyses and measurement enabling early identification of potential opportunities.

Mishra & Sandilya, (2009) defines quality as fitness for use, and this definition have been applied to IQ (Batini et al., 2009; Haug et al., 2013; Sebastian-Coleman, 2013; Wand & Wang, 1996; R. W. Wang et al., 1996). The fitness of use definition posits that the quality of a product or service entails the possession of particular attributes. These attributes are used in determining the level of quality associated with such product or service. Taking on this perspective, Herrala, (2007) and R. W. Wang et al., (1996) provides a list of IQ attributes that can be used to determine the quality of the utilised information . This list of attributes have been classified into specific IQ dimension (Chaffey & Wood, 2005; Koronios et al., 2005; S. Lin et al., 2006; R. W. Wang et al., 1996). These dimensions are the latent construct that account for each attributes (Figure 2:14) and can be identified using sophisticated analytical techniques.

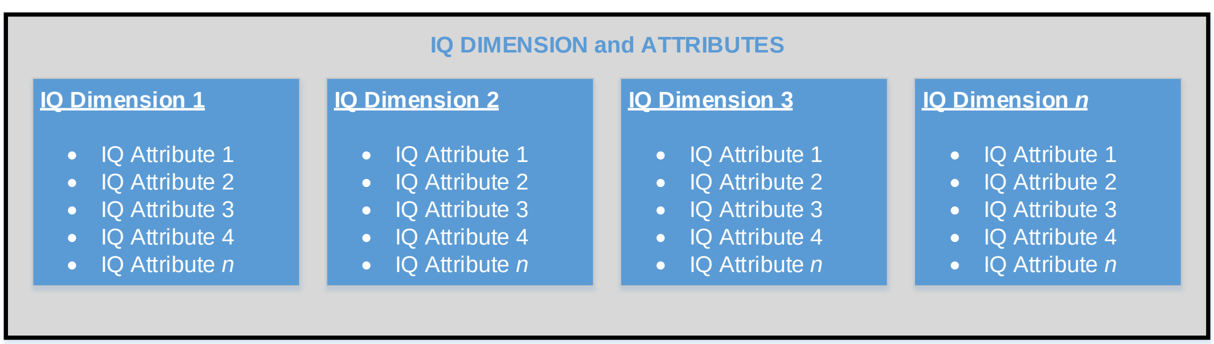


Figure 2:14 Schematic Diagram of IQ Dimensions and Attributes

However, previous research in determining the dimensions of IQ have adopted an intuitive approach which is based on the researchers experience or instinctive understanding of what IQ attributes are important (Batini et al., 2009; English, 1999; S. Lin et al., 2007; Wand & Wang, 1996). This inadvertently results in a small set of quality attributes being identified and investigated (R. W. Wang et al., 1996). It presents a significant limitations in IQ studies as it leads to IQ treated as an intrinsic concept independent of the context in which it is produced and used (Strong et al., 1997). It fails to provide a close approximation of the dimensions of IQ based on the operation performed by the actors within an organisation.

From the review of the literature, factors have been seen to affect the quality of information in AM within the operational context from the information, organisational, and people domains (Figure 2:15). However, there is a preponderance for these factors to be limited to IT problems. In addition to this, the operational context is subsumed within an organisation, which is further influenced, by its size and structure (Figure 2:15). Though attempts have been made in examining IQ from an organisational size perspective (Haug et al., 2013), it is not evident if the size or structure has a main effect on IQ. This is a significant limitation of previous studies, which this research shall seek to determine.

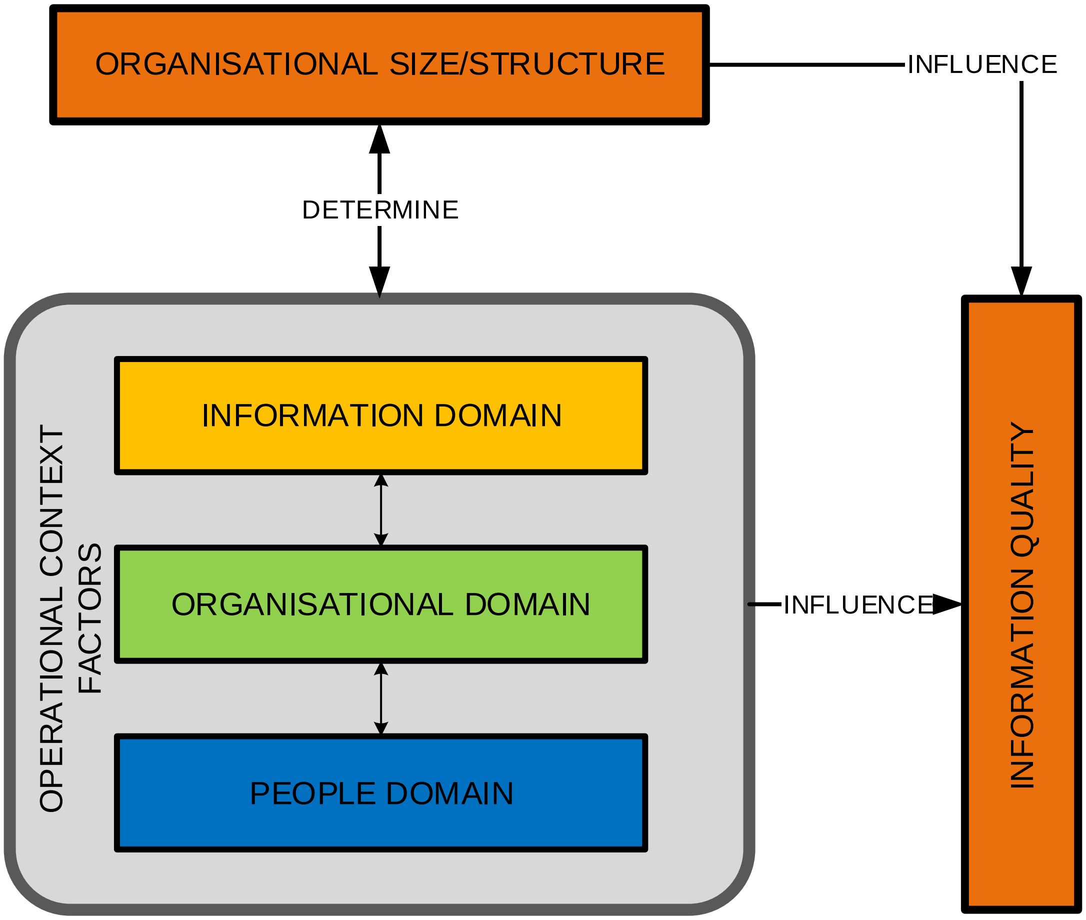


Figure 2:15 Factors Affecting IQ

S. Lin et al., (2006) research identified several issues affecting the quality of information in AM engineering companies in Australia. The limitations to the study are (1) the applicability and transferability of the findings in a different geographical context, and (2) the methodology adopted. Hence, it is pertinent to examine what factors within the operational context of FM affect IQ of AM programs in another geographical context.

Finally, the review showed that as information evolve and become more complex the techniques required to assess and improve its quality become varied. In regard to this, the inability to assess the quality of information causes performance problems in organisations (Y. W. Lee et al., 2002). The review indicates that several methods have been developed that seeks to assess appropriately the quality of information (Batini et al., 2009). These methodologies are diverse and vary in complexity with special areas of application but have been unable to enhance the quality of information used in AM (S. H. Lee & A. Haider, 2014). Examples include TIQM, IQAF, AIMQ, IQM-CMM, and IQ Grid. Some of the limitations to these methods include (1) a lack of methodological underpinning, (2) the inability for organisation to understand the process or procedure of the method, and (3) the inability to provide a contextual identification of specific IQ dimension. Therefore an approach and assessment tool, having a theoretical underpinning, is required for the ease of assessing the quality of information used in AM. This study suggests and will apply the use of a perceptual map in the final framework. It is proposed that this shall enable the ease of assessment of IQ. Section 3.7.2 of Chapter 3 provides an expanded discussion of the perceptual map.

These limitations identified in the review shall be addressed in this research towards developing a framework that can be used in assessing IQ using empirical techniques. To achieve this a thorough discussion of the philosophical position and methodological principles that underpins the research shall be presented. This will provide the foundation towards determining the data collection and analysis process that will further assist in addressing the questions posed in this study. In view of this, the succeeding chapter (Research Methodology, Chapter 3) provides the discussion and justification of the procedures used in this thesis.

Chapter 3 Research Methodology

Evidence from the literature suggest that various understanding of IQ exists on which the contextual nature of information is premised. This presents a methodological challenge in identifying what dimensions of IQ are relevant to and influences AM programs undertaken by FM organisation. Thus, it is imperative to present a methodological outline that will enable this research answer the questions and meet the objective as stated in Chapter 1 .

The essence of a research process is to answer the research question(s) by evoking suitable evidence, supported by a robust argument (Wall, 2009). Wall, (2009) refers to this as a paradigm. A paradigm of research is a theoretical framework which consist of a system that enables individuals perceive reality (Wall, 2009). Bryman, (2008) defines paradigm as a cluster of beliefs, which influences what should be studied, how research should be done, and how results should be interpreted. This is akin to philosophy. This chapter aims to describe the study primary philosophical position and strategy. In addition to this, the chapter will present and justify the techniques utilised for the collection, analysis, and validation of the research data.

The research methodology presents the research design and the specific procedures used in conducting the study. The choice of the research approach, according to Bloomberg and Volpe, (2008a), is directly tied to the research problem and purpose. Four fundamental facets of research i.e. ontology, epistemology, methodology, and method provide the framework for planning, implementing, and evaluating research (Carter & Little, 2007; Grbich, 2007; Saunders et al., 2012). A structure for this research has been developed based on these principles of which the design seeks to guarantee rigour in the whole research process.

Prior to designing the structure, an outline of various philosophical schools of thoughts will be analysed, and reasons for adopting the chosen philosophical stance shall be discussed. In light of this, the next section discusses the process at arriving at the implemented research methodology and method adopted for conducting this research. The aim here is to inform the reader of this text on why and how the strategy and method were formulated. It begins with an exploration of the philosophical positions and schools of thought associated with understanding the phenomenon of reality, followed by a discussion on methodology and methods. The succeeding section discusses the structure adopted for this research, with an explanation on how this structure links with the philosophical schools of thought. It aims to give the reader a holistic view of the entire research methodology.

3.1 Philosophy

Philosophy, according to Williams et al. (1996), is concerned with knowing what kind of things exist in the world and enable the process of truth construction. The nature of inquiry into reality is defined by the philosophical position adopted by the observer of reality. Herrman, (2009) states that philosophy involves learning the background realities that account for what we can know, or think we can know, by developing and applying methodologies that ask the right questions and seek the simpler connections within and among complexities.

Research philosophy constitutes a belief about the way in which facts about a phenomenon should be gathered, analysed, and used in a field of study (Davidson, 2004). Caplinskas & Vasilecas, (2004) and Ranjit, (2012) acknowledged that research philosophy underpins the mode of inquiry and plays an important role in research process within a particular academic discipline. As such, the decision to study a topic in a particular way involves a kind of philosophical choice about what is important (Easterby-Smith et al., 2001).

Choosing a research methodology necessitates a philosophical assumption (Holden & Lynch, 2004). Developing a philosophical perspective requires that the researcher make several assumptions concerning ontology (reality), epistemology (knowledge), human nature (Axiology: pre-determined or not), and methodology (Holden & Lynch, 2004) which enhances confidence in the appropriateness of the adopted methodology and confidence in the research results. Easterby-Smith et al., (2001) provide explanation to the various component that permits the understanding of research (Table 3:1).

Table 3:1 Ontology, Epistemology, Methodology, and Methods (Easterby-Smith et al., 2001)

Ontology:	Assumptions that we make about the nature of reality
Epistemology:	General set of assumptions about the best ways of inquiring into the nature of world
Methodology:	Combination of techniques used to enquire into a specific situation
Methods:	Individual techniques for data collection and analysis

Ranjit, (2012) emphasises the need for a critical examination of research philosophy and notes that this has a bearing on the methodology adopted. According to Ranjit, (2012), research design are more philosophically guided than methods based. For instance, feminist research is influenced by the philosophy that opposes and challenges the dominant male bias in social science research (Ranjit, 2012). Therefore, the nature of philosophy are the basic belief systems or worldview that guides the investigation in all facet of the research (Saunders et al., 2012). Consequently, it is imperative that the researcher is aware of the influence in selecting the appropriate research philosophy relating to the various areas of enquiry towards the attainment of the research objective. Easterby-Smith et al., (2001) provide three reasons why understanding and selecting the appropriate philosophical position is relevant to research:

1. It helps to clarify research design by considering what kind of evidence is required and how it is to be gathered as well as providing answers to be research question
2. It helps the researcher to recognise which design will work by indicating the limitation of particular approaches
3. It helps the researcher identify and create research designs that can be adapted to the constraints of different subject or knowledge structures

The next section discusses the different dimension to philosophy assumptions in research by exploring the principles of ontology, epistemology, methodology, and methods respectively.

3.1.1 Philosophical Assumptions – Ontology

The researcher view of reality is the cornerstone to all other assumptions, that is, what is assumed here predicates the researchers other assumption (Holden & Lynch, 2004). The nature of reality and its construct is determined by the philosophical assumptions adopted within a piece of study and shapes various investigation into the meaning of events and phenomena (Schutt, 2012). Therefore it is unwise to conduct research without any form of awareness of the philosophical issue that guides the realities or research (Easterby-Smith et al., 2001).

The foundation of scientific and social reality lies on the ontological perspective of the observer. Questions about what reality is i.e. how reality is formed or what constitute reality, form the basis of ontology. Ontology deals with questions concerning what entities exist or can be said to exist, and how such entities can be grouped, related within a hierarchy, and subdivided according to similarities and differences (J. Hughes, 1983). According to Grix, (2001) ontology is the image of reality upon which a theory is based, or, alternatively, the study of reality through the conceptualisations of essence that underpin the particular domain under study (Grbich, 2007). Thus, the question, "…what is the nature of the reality to be investigated..." needs to be answered before we can proceed.

The reality that constitutes this research is the social entity of the organisations and the phenomenon therein being investigated, and this determines the ontological position adopted. Unlike scientific experiments, which are deterministic, social experiments and phenomena are dynamic, seldom deterministic and often constructed (Grbich, 2007; J. Hughes, 1983). This has been highlighted in social science research debates as compiled by J. Hughes, (1983). Understanding these social phenomena depends on the ontological positions adopted which exist on the continuum of (1) objectivism, and (2) constructivism (subjectivism) (Bryman, 2008; Grix, 2001; Saunders et al., 2012).

1. Objectivism is an ontological position that asserts that social phenomena and their meaning have an existence that is independent of social actors (Bryman,

2008; Grix, 2001). In this ontological position, social phenomena are treated as observations independent of the interacting participants and observed via a disassociated or non-invasive approach

2. Constructivism (subjectivism) is the ontological position that asserts that social phenomena and their meanings are continually being accomplished by social actors through social interactions, are in a constant state of revision and confront us as external facts that are beyond our reach or influence (Bryman, 2008; Grix, 2001; Saunders et al., 2012). This position in social science research has been acknowledged by researchers to achieve a holistic rather than a reductionist understanding of the social situation (Bloomberg & Volpe, 2012)

Ontological assumptions about what exists inevitably lead to issues about how what exists may be known – the epistemology.

3.1.2 Philosophical Assumptions – Epistemology

Different views of reality exist, and some seem more dominant over the other. This is true of the scientific discipline that aims to explain reality through theories and laws. For instance Efinger, Maldonado, & Geri McArdle, (2004) notes that science is objective, value-free, and context-free to the extent it represent reality as mechanistic mathematical models. However, debates on the nature of reality have divided observers' views about what reality is and how that should be interpreted. Based on this dichotomy, reality is viewed as not an independent artefact but constructed based on the observer(s) beliefs. The arguments that subsumes these views are premised on epistemological positions Babbie, (2010).

Epistemology – the theory of knowledge – deal with questions about truth i.e. what we accept as truth and how this has been constructed (Carter & Little, 2007; Grbich, 2007; J. Hughes, 1983). Based on this, the conceptualisation of reality is derived from the process we gather and organise the signs and symbols we observe. Epistemology is inextricable linked to the research process where the theory of knowledge is adopted implicitly or explicitly by the researcher (Carter & Little, 2007).

Epistemology has a focus on the knowledge gathering process with the aim of developing new models of theories (Grix, 2001). It provides a potential connection between research practice and formal theories of knowledge because it, according to Carter and Little, (2007), influences the choice of methodology, the relationship between the researcher and the participant, the way in which quality of methods is demonstrated and the form, voice, and representation in the method. Thus it is difficult to engage in knowledge creation without at least a tacit assumptions of epistemological positions i.e. assumptions of what knowledge is and how it is constructed (Carter & Little, 2007). However, it should be noted that questions about epistemology are not to be answered by empirical inquiry as they are questions requiring philosophical argument and debates in which the very presuppositions of knowledge are of concern (Bryman, 2008; J. Hughes, 1983).

Several epistemological schools of thought interpret reality as fixed or dynamic or existing on a continuum of which claims can be determined either rationally through reason and observation or construction and deconstruction of a phenomenon (Bloomberg & Volpe, 2012; Grbich, 2007). These include positivism, realism, social constructivism (interpretivist or naturalistic inquiry), critical theory or advocacy, and pragmatism or postmodernism (Bloomberg & Volpe, 2012; Grbich, 2007; Saunders et al., 2012). The nature of these epistemological positions further bears an influence on methodology which has an overarching bearing to the research in approximating results in the same or a similar setting (Bryman, 2008; Carter & Little, 2007; J. Hughes, 1983).

3.2 Methodology

It has been observed by Carter and Little, (2007), and Grix, (2001), that methodology has been used loosely in research and is often confused to refer to several opinions such as theories, schools of thought or movements such as feminism, whole disciplines such as anthropology, or methods such as focus groups or observation. Thus, it is important to understand the purpose of “methodology” in research as not to be entangled in a web of confusion or misinterpretations.

Methodology is the branch of philosophy that analyse the principles and procedures of inquiry in a particular discipline (TheSage English Dictionary and Thesaurus, 2014). It is the theory of how research should be undertaken (Saunders et al., 2012). Bloomberg and Volpe, (2008b) makes us understand that the research methodology is shaped by research objectives, questions, and study design. But on the contrary, Carter and Little, (2007) argues that this relationship operates in two directions i.e. research objectives, questions, and study design shape the choice of methodology, and methodology shapes the research objectives, questions, and study design. Carter and Little, (2007) further posit that methodologies can proscribe or encourage the use of existing formal and substantive theories during analysis and in interpretation of findings.

The explicit discussion of methodology is often a topic avoided in research due to the confused notion it presents. As such, a stand-alone chapter dedicated to methodology seldom exist in published PhD. As indicated, this is predominantly due to the loose interpretation of the term methodology (Carter & Little, 2007; Easterby-Smith et al., 2001; Grix, 2001). For instance Saunders et al., (2012) uses strategies while Creswell, (2014) uses approach. According to Carter & Little, (2007) methodology has been used to refer to formal theories, schools of thought or movements such as symbolic interactionism or feminism, whole disciplines such as anthropology, or methods such as focus groups or observation.

Grix, (2001) and Easterby-Smith et al., (2001) noted that the difficulty in understanding the term methodology stems from the fact that it is used interchangeably with research methods and often considered to be close in meaning to epistemology, approaches, and paradigms. However, methodology is a significant component of research and differs from the philosophies – ontology and epistemology, and methods in meaning. According to Easterby-Smith et al., (2001) methodological choices for research should be informed by the philosophy, as this represents the means available to investigate phenomena (Holden & Lynch, 2004). It should further be understood as the critical study of research methods and their use (Grix, 2001).

At this point, it is imperative to provide a meaning of methodology and situate it within the context of this research. The OED, (2015) defines methodology as the branch of knowledge that deals with method generally or with the methods of a particular discipline or field of study. Carter & Little, (2007), provides an elaborate definition of methodology as a theory and analysis of how research should proceed, analysis of the assumptions, principles, and procedures in a particular approach to inquiry and the study of methods. Kuhn, (2005) views methodology as the systematic, theoretical analysis, and principles of the body of methods associated with a branch of knowledge. It encompasses concepts such as paradigm, theoretical model, phases and quantitative or qualitative techniques (Kuhn, 2005). Grix, (2001) argues that methodology is concerned with the discussion of how a particular piece of research should be undertaken which is driven by certain ontological and epistemological assumptions. Holden & Lynch, (2004) supports this view as well in the following statement:

> *"…a research methodology represents how the research should be undertaken, which involves the assumptions the researcher has already made..."*

Saunders et al., (2012) also states that methodology is the theory of how research should be undertaken including the philosophical assumptions upon which research is based and the implications of these for the methods or methods adopted. This indicates that methodology adopted within a research study is directly influenced by the ontological and epistemological assumptions of the researcher (Carter & Little, 2007). Carter & Little, (2007) goes further to argue that the use of methodology in research should be considered a vital component because the objectives, research questions, and design are influenced by the choice of methodology and vice versa. This iterative decision-making process enables a unique solution for the particular research study (Carter & Little, 2007).

Methodology is the logic that justify, explain, and help understand research methods used to systematically solve the research problem (Carter & Little, 2007; Kothari, 2012). They provide the researcher with an overall strategy for formulating, articulating, analysing, and evaluating the methods adopted in the research (Carter & Little, 2007). As such, they do not set out to provide solutions but offers the theoretical underpinning for understanding which method can be applied to a specific case (Kuhn, 2005).

Since methodology can prescribe choices of methods and encourage the use or development of theory (Carter & Little, 2007), inappropriate matching of methodology to research problem may result in questionable outcomes (Holden & Lynch, 2004). Therefore, methodology should be seen as a strategy by which the researcher maps out an approach to problem-finding or problem-solving (Buckley et al., 1976). This should incorporate a set of techniques used in generating or testing theory or problem solving (Buckley et al., 1976). Therefore, researchers need to understand the assumptions underlying various techniques and they need to know the criteria by which they can decide that certain techniques and procedures will be applicable to certain problems (Kothari, 2012). This means that it is necessary for the researcher to design a methodology for the problem as the same may differ from problem to problem (Kothari, 2012).

In summary, methodology provides justification for the methods of a research project which produces data and analyses (Carter & Little, 2007). It is influenced by the research philosophy, objectives, questions, and aim, and represents how the research should be undertaken, which involves the assumptions the researcher has already made (Carter & Little, 2007; Holden & Lynch, 2004). Creswell, (2014) and Saunders et al., (2012) elucidates examples of methodologies which justify the methods used in research, and these are presented in Table 3:2.

Table 3:2 Examples of methodologies that justify the methods

Experiment	A study of the causal links whether a change in one independent variable produces a change in another dependent variable
Survey	Involves the structured collection of data from a sizeable population
Grounded Theory	Theory is developed from data generated by a series of observations or interviews principally involving an inductive approach
Ethnography	Focuses upon describing and interpreting the social world through first-hand field study
Action Research	Concerned with the management of a change and involving close collaboration between practitioners and researchers
Phenomenology	Sees social phenomena as socially constructed, and is particularly concerned with generating meanings and gaining insights into phenomena
Case Study	Involves the empirical investigation of a particular contemporary phenomenon within its real-life context, using multiple sources of evidence
Archival Research	Analyses administrative records and documents as principal source of data because they are products of day-to-day activities
Mixed Methodology	Incorporates the use of quantitative and qualitative in a sequential, concurrent, or transformative approach to explore or explain a phenomenon in great detail

Based on this outline, a positivist (quantitative) approach to research is most likely to adopt one of the following types of methodologies (Bloomberg & Volpe, 2012):

1. Descriptive research: involves collecting data to test hypotheses or answer questions about the current status of the subject of inquiry
2. Correlational studies: involves collecting data to determine whether and to what degree a relationship exists between two or more quantifiable variables
3. Causal-comparative research: attempts to determine the cause or reason for existing differences in the behaviour or status of groups of individuals
4. Experimental research: this includes true experiments as well as the less rigorous experiments or quasi-experiments

while a constructivist or critical perspective (qualitative) approach to research is most likely to adopt one of the following types of methodologies (Bloomberg & Volpe, 2012; Creswell, 2014; Grbich, 2007; Silverman, 2011; Yin, 2009)

1. Case Study: an intensive description and analysis of a phenomenon, social unit, or system bounded by time or place

2. Ethnography: study of a cultural or social group in its natural setting, closely examining customs and ways of life, with the aim of describing and interpreting cultural patterns of behaviour, values, and practices
3. Phenomenology: an approach to understand the meanings and the essence of lived experience together with how participants described and make sense of them
4. Grounded Theory: an attempt to generate or discover a theory of a process, action, or interaction grounded in the views of the research participants
5. Narrative Inquiry: the study of the lives of one or more individuals through the telling of stories of which the information gleaned from the story or stories is then retold by the researcher into a "narrative chronology."
6. Hermeneutics: the interpretation of various form of information such as texts or transcribed meanings
7. Mixed Methodology: Incorporates the use of quantitative and qualitative in a sequential, concurrent, or transformative approach to explore or explain a phenomenon in great detail

3.3 Methods

From the discussion in the above section, it can be deduced that research methodology has many dimensions and research methods do constitute a part of the research methodology (Kothari, 2012). Though, the scope of research methodology is wider than that of research methods (Kothari, 2012) it is imperative to consider the logic behind the methods used in the context of the research study and explain why a particular method or technique has been adopted.

Methods may be understood as the science of studying how research is done (Kothari, 2012). Kothari, (2012) posits that research method is constrained by and makes visible methodological and epistemic choices, a view supported by Carter & Little, (2007). However, Grix, (2001) argues that though the choice of methods is influenced by ontological and epistemological assumptions, they should be free from such assumptions but guided by the research questions. Here the method does not inform the research but the researcher (Grix, 2001).

Research methods can be seen as the techniques or procedures used to collate and analyse data (Carter & Little, 2007; Grix, 2001). Bryman, (2008) suggests that research methods are associated with different kinds of research designs. Research methods as defined by Bryman, (2008) are techniques for collecting data which involve specific instruments such as questionnaire, interview schedule or participant observation. Carter & Little, (2007) goes further to indicate that they are the practical activities of research i.e. sampling, data collection, data management, data analysis, and reporting. These are inextricable linked to the research questions posed and the sources of data collected e.g. interviews, transcripts, documents (Grix, 2001). According to Grix, (2001) methods have two principal functions in research

1. They offer the researcher a way of gathering information or gaining insight into a particular issue (essential for concentrating and narrowing a line of enquiry)
2. They enable another researcher to re-enact the first's endeavours by emulating the methods employed (essential in validating research)

Research methods have broadly been classified into two categories: (1) quantitative methods, and (2) qualitative methods. The quantitative strand has predominantly been associated with the positivist school of thought while the qualitative strand has been associated with the constructivist school of thought (Saunders et al., 2012).

Quantitative methods record variation in terms of quantities where data are regarded as numbers or attributes that can be ordered in terms of magnitude (Schutt, 2012). According to Grix, (2001) quantitative methods is characterised by three phases: finding variables for concepts, operationalising them and measuring them. This approach tends to abstract the researcher from particular instances to seek general description or to test causal hypotheses (Grix, 2001). As such the process of data collection becomes distinct from analysis (Easterby-Smith et al., 2001). Grix, (2001) goes further in stating that quantitative techniques include identifying general patterns and relationships among variables and making prediction based on the results.

Qualitative methods, forming the second strand, is a research method that involves the collection of textual data (Bryman, 2008). It involves in-depth investigation of knowledge through various mechanisms such as participant observations, interviewing , archival and documentary analysis, or ethnographic studies (Grix, 2001). Qualitative methods are designed to capture social life as participants experience it rather than in categories predetermined by the researcher (Schutt, 2012). They rely on written, spoken, or observations that do not often have a direct numerical interpretation and typically involve exploratory investigation (Schutt, 2012). Easterby-Smith et al., (2001) examines qualitative methods as an array of interpretative techniques that seek to describe, decode, and translate the meaning of certain naturally occurring phenomena. Information in qualitative methods is derived from events or issues with a view to discerning patterns, trends, and relationships between key variables (Grix, 2001). It involves the interpretation of few data in their social and cultural context over a specific period.

Research involving qualitative studies are often not detached from the object of study, which is a contrasting feature of quantitative studies (Eisenhardt, 1989; Grix, 2001). Another contrasting feature between qualitative and quantitative study is the issue of generalisability. Grix, (2001) argues that qualitative studies are often small-scale and not generalizable beyond the context. Table 3:3 provides a comparison between quantitative and qualitative methods based on the notions presented by (Eisenhardt, (1989) and Grix, (2001).

Table 3:3 Comparison between Quantitative and Qualitative Methods (Eisenhardt, 1989; Grix, 2001).

Quantitative	Qualitative
Tackle macro issues	Analyses micro issues
Deductive research strategy	Inductive research strategy
Positivist tradition	Interpretative tradition
Theory testing and predictive	Theory generating
Aims to identify patterns and relationships	Aims to interpret event of historical and cultural significance

According to Creswell, (2014) qualitative data tends to be open-ended without predetermined responses while quantitative data usually includes closed-ended responses. Creswell, (2014) goes further to indicate quantitative and qualitative methods can be mixed in research (Table 3:4) and presents three mixed method designs that can be applied to research:

1. Convergent parallel mixed method: qualitative and quantitative data are converged to provide a comprehensive analysis of the problem. The researcher collects and integrates data at approximately the same time for the interpretation of the result.
2. Explanatory sequential mixed methods: this approach seeks explanation of a phenomenon by collecting quantitative data and then qualitative data in a sequence. In this method, the researcher collects quantitative data, analyses the results and builds on the results to explain in more detail the findings with qualitative data.
3. Exploratory sequential mixed methods: the researcher in this approach begins with a qualitative research phase to explore the view of the participants. The collated data is subsequently analysed of which the results is built into a second quantitative phase. This approach allows the research to fine-tune the study by specifying the variables that needs to be investigated and developing instruments that best fits the sample under study.

Table 3:4 Description of Quantitative, Qualitative, and Mixed Methods (Creswell, 2014)

Quantitative methods	Mixed methods	Qualitative methods
Pre-determined	Both predetermined and emerging methods	Emerging methods
Instrument based questions	Both open and close ended questions	Open ended questions
Performance data, attitude data, observational data and census data	Multiple forms of data drawing on all possibilities	Interview data, observation data, document data, and audio-visual data
Statistical analysis	Statistical and text analysis	Text and image analysis
Statistical interpretation	Across databases interpretation	Themes, patterns interpretation

3.4 Research Framework

This section discusses the research design that is being utilised for this study. The research structure is the fusion of the methodology and the methods used in developing and validating new knowledge. This is influenced by the ontological and epistemological position adopted by the researcher. The research structure shows how each of these interrelated components and decisions interact to answer the research question. According to Kothari, (2012), in research, the scientist has to expose the research decisions to evaluation before they are implemented. Amaratunga, Baldry, Sarshar, & Newton, (2002) also argues that the type of question posed, the control over actual behavioural elements, and the degree of focus on historical or contemporary events are the conditions necessary to provide the justification for the choice of strategy. Amaratunga et al., (2002) go further to indicate that this is necessary to avoid incompatibilities between the desired outcome and the chosen research strategy. It is, therefore, important to specify very clearly and precisely what decisions have been selected and why select them so that they can be evaluated by others (Kothari, 2012).

To begin with the construction and explanation of the research structure, it is important to revisit the aim of the research, which is to develop a framework to enable facilities management professional assess the quality of information used in asset management programs. Based on this the following questions have been posited:

1. How prevalent is the issue of information quality (IQ) in the (FM) industry?
2. Which IQ dimensions are significant for effective AM activities?
3. How can the quality of asset information be assessed in FM operations?

It can be observed that each of these questions begins by asking "how" and "which". This goes to suggest that the nature of this research seeks to explore particular issues or phenomenon within a social context. This has inextricably influenced the choice of the research philosophy and the research methodology. These subsequently have a bearing on the methods used in the process of data collection and analysis.

Ensuring rigour is an important aspect of research. This entails how the study is performed and how the methodology is conceptualised (Ravitch & Riggan, 2012). Ravitch & Riggan, (2012), further added that this would incorporate the arguments supporting the relevance of the research questions, the raw data needed to explore the research question, and finally the analytical approach that allows the researcher to respond to the research questions. To this end, several authors have suggested peculiar approaches to achieve rigour in research (Mike Kagioglou, 1998; Ravitch & Riggan, 2012). A well know and widely adopted approach is that proposed by Saunders et al., (2012) known as the "research onion" (Figure 3:1) which have been used by many PhD researchers.

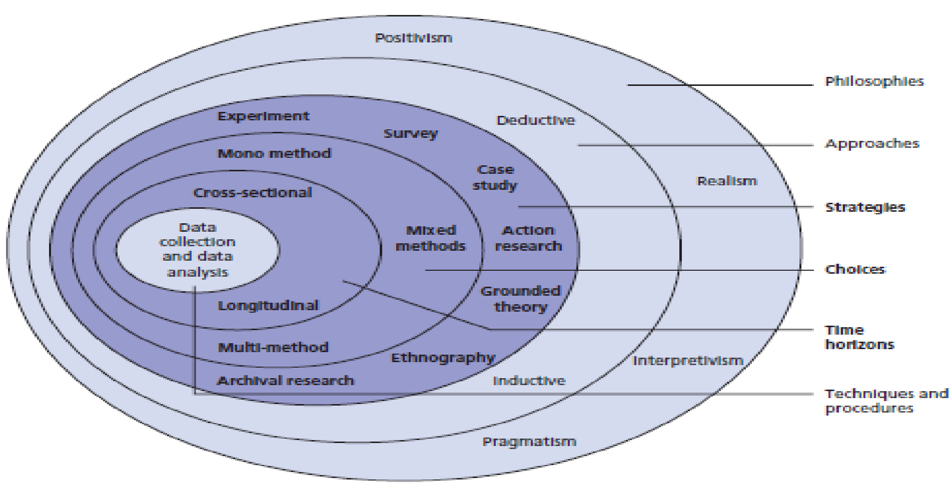


Figure 3:1 The Research Onion By (Saunders et al., 2012)

The research onion approach is interpreted as consisting of layers that attempts to explain reality that, when peeled, reveals deeper meaning towards knowledge gathering. Theoretically, this would be considered a risky approach to ensuring rigour in the research as it suggest following a single pathway in the research giving no allowance for re-evaluation of the research strategy thus leading the researcher into difficulties. To ensure rigour and lessen any risk for the process of this research, a knowledge development structure with a '*3A*' principle i.e. Adequate, Available and Applicable, is developed and utilised (Figure 3:2). In this context, the following meaning is associated with each concept:

1. Adequate: the current knowledge has the requisite qualities or resources to meet a task
2. Available: the current knowledge is obtainable or accessible and ready for use or service
3. Applicable: the current knowledge is capable of being applied and/or having relevance

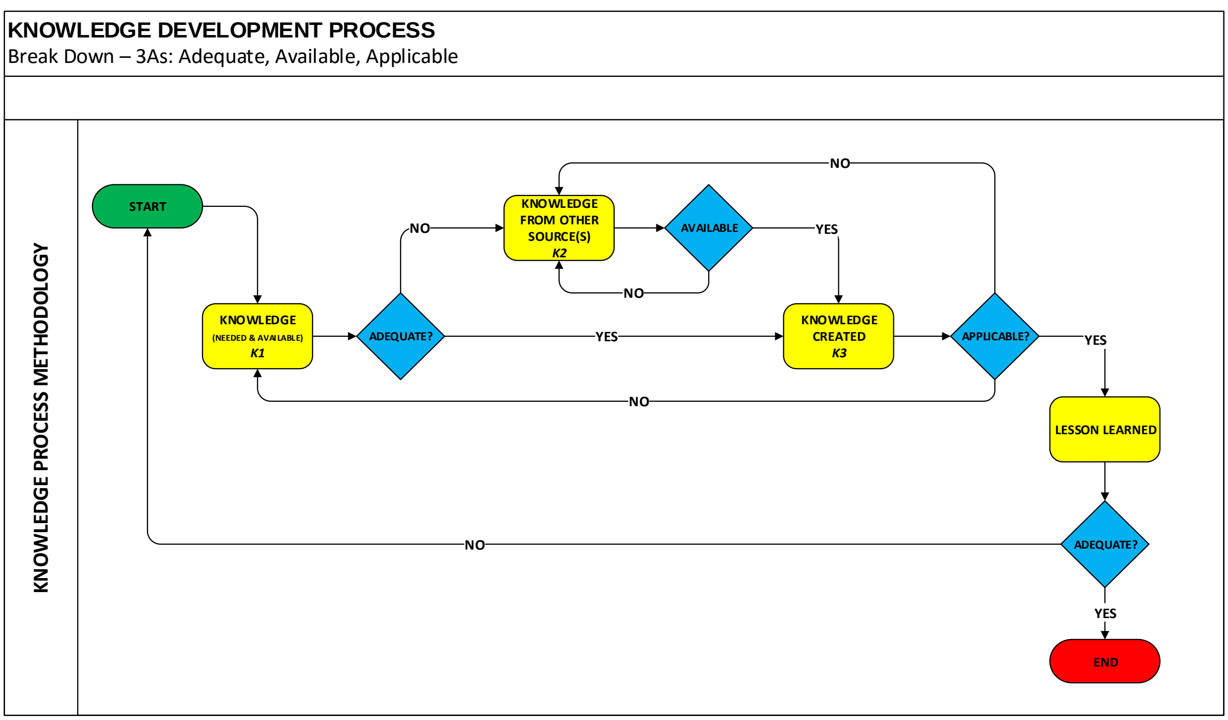


Figure 3:2 Knowledge Development Process

This process seeks to guarantee knowledge adequacy, knowledge availability and knowledge applicability in research by iterating through the knowledge blocks (*K1, K2, and K3*) (Figure 3:2). Using this structure, the research begins with an analysis of the knowledge required (needed and available) for the research (*K1*) which represents reality. Where such knowledge is found to be inadequate, knowledge from other sources i.e. literature and social context (*K2*) is utilised. Otherwise, new knowledge is created, and the research endeavour is not required. Using this approach, *K1* is validated, and in this way, new knowledge can be created (*K3*). When or if such knowledge is applicable, lessons can be learnt from the process and if found to be adequate, a new theory, concept or approach can be adopted. Therefore, knowledge, although not absolute, can be accumulated, tested, and either retained or discarded through this process (Holden & Lynch, 2004).

The blocks within this structure (*K1, K2, and K3*) is inextricably linked to the fundamental facets of research: ontology, epistemology, methodology, and method in the research framework (Figure 3:3). This framework is designed to iterate through the knowledge blocks (*K1, K2, and K3*) constituting of; (1) the philosophical level [*K1*], (2) the reasoning level [*K2*], and (3) the data level [*K3*] (Figure 3:2 and Figure 3:3). This aims to certify rigour in the knowledge delivery process and ensure reliability and axiology of the research is achieved. Each elements of the research framework is explained in the succeeding section.

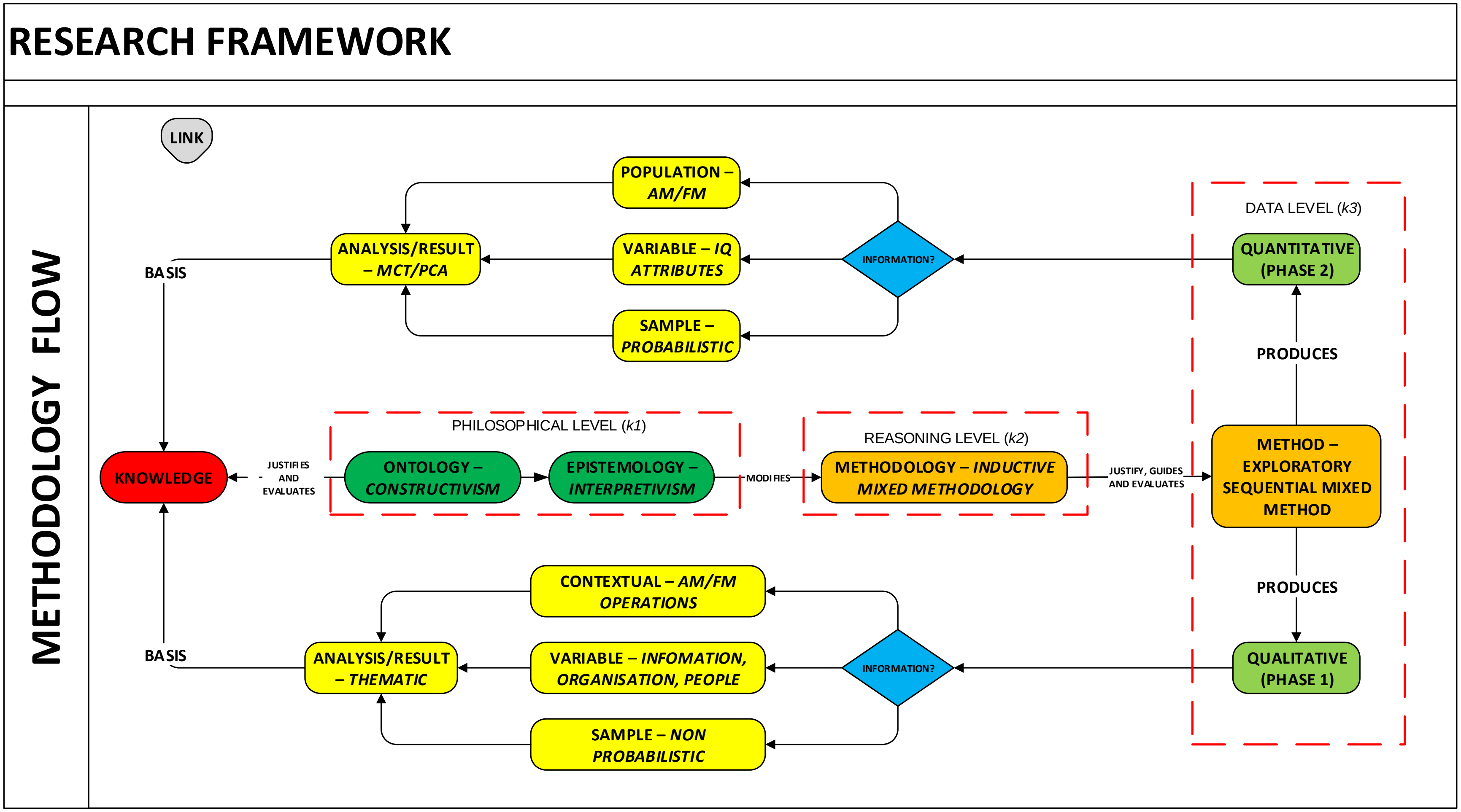


Figure 3:3 Research Methodology Framework

3.4.1 Adopted Research Philosophy (Philosophical Level [K1])

The quest for knowledge and truth and how they are constructed in reality has been the foundation of research, both social and scientific. It seeks to clarify our concepts, transcend the particularity of disciplinary boundaries and ask questions about those things observed (J. Hughes, 1983; M. Williams et al., 1996). The process of attaining this knowledge and truth stems from the methodology adopted by the researcher. The choice of a research methodology is influenced by the philosophical stance of the researcher of which are classified as the ontological stance and epistemological position (Grbich, 2007; J. Hughes, 1983). Bloomberg and Volpe, (2008a) noted that researchers philosophically make claims about what knowledge is (ontology), how we know what we know (epistemology), what values go into knowing what we know (axiology). Thus, it is essential to identify and understand these ontological and epistemological traditions within this process of research design (Grbich, 2007).

Constructivism (subjectivism) and interpretivism have been adopted as the ontological and epistemological positions respectively in this research and is presented here as the philosophical level [K1] (Figure 3:3). Constructivism (subjectivism) is an ontological position that asserts that realities are created from the perceptions and actions of social actors where understanding is achieved by interaction with the social actors (Bloomberg & Volpe, 2012; Saunders et al., 2012). Interpretivism is the epistemological position that advocates the necessity to understand differences between humans in their role as social actors (Saunders et al., 2012). By adopting these positions, it enables the researcher to understand the phenomenon and dynamics taking place within the researched environment. It proffers a worldview where no object acts in isolation.

3.4.2 Adopted Research Methodology (Reasoning Level [K2])

Bloomberg and Volpe, (2008a) noted that the processes for studying knowledge is known as methodology. The research methodology is presented here as the reasoning level [K2]. It helps the researcher define the research study approach and strategies for data collection but can easily be confused with methods in research. The approach to this study adopts primarily an inductive research perspective, of which an inductive mixed methodology is adopted. As such, the research leans strongly to the interpretivist research paradigm.

The inductive mixed methodology is an approach to inquiry involving collecting both quantitative and qualitative data (Creswell, 2014). This aims to guide the process of inquiry through gathering extensive insight into the research questions thereby moving from specific observations to broader generalizations and theories (Burney & Saleem, 2008). The rationale for using an inductive mixed methodology is based on the domain of study[6], research problem and research questions which seeks to provide broad generalizations to the concept of IQ in FM (Bloomberg & Volpe, 2012; Carter & Little, 2007; Saunders et al., 2012). According to Amaratunga, Baldry, Sarshar, & Newton, (2002), the inductive mixed methodology is predominantly used in the BE to study the emerging phenomenon. The essence is to explore the phenomenon within its context, i.e. IQ in FM operations (Amaratunga, Baldry, et al., 2002). According to Eisenhardt and Graebner, (2007), inductive mixed methodology enables the researcher gain rich understanding of the problem context and the processes being enacted within. It has the ability to generate answers to the question 'which' and 'how' (Saunders et al., 2012). Inductive mixed methodology adopts an approach to research where theory development is the focus (Eisenhardt, 1989). The selected methodology assumptions further determine the choice of methods adopted in the research study data collection exercise (Grix, 2001).

The methodology explains, justifies, and evaluates the methods used in research and how such research should proceed (Carter & Little, 2007; Grix, 2001; Saunders et al., 2012). Thus it can be implied that the research inquiry methodology justifies the research methods adopted (Bloomberg & Volpe, 2012; Bryman, 2008; Carter & Little, 2007) and has a direct influence on data collection and analysis. This can be combined

[6] The Built Environment

or altered, providing that the researcher retains a coherent epistemological position (Carter & Little, 2007).

3.4.3 Adopted Research Method (Data Level [K3])

This section describes the research method, which represents the systematic approach to the data collection for this research representing data level [K3]. Research methods are techniques or procedures used to collate and analyse data (Grix, 2001; Saunders et al., 2012). It constitutes the actions of the researchers and participants in a research project which involves sampling, data collection, data management, data analysis, and reporting (Carter & Little, 2007).

Methods in research have two principal functions (Grix, 2001):

1. They offer the researcher a way of gathering information or gaining insight into a particular issue
2. They enable another researcher to re-enact the first endeavour by emulating the methods employed.

Methods are the praxis[7] by which methodology and epistemology become visible (Carter & Little, 2007). The choice of research method for this study is inextricably linked to the research question(s) being asked and the objectives of the research being investigated (see Chapter 1) which is further influenced by the ontological and epistemological position (Bloomberg & Volpe, 2012; Carter & Little, 2007; Grix, 2001).

[7] Translating an idea into action

As noted in Chapter 1 , the objective of the study seeks to identify, classify, examine, and evaluate factors that affect the quality of asset information. Therefore, two methods will be applied in order to achieve the objectives of this research (Table 3:5):

Table 3:5 Research Objective and Method Used

Number	Research Objective	Method
1	To examine what factors influence asset management (AM) information quality (IQ) in facilities management service (FM)	Qualitative
2	To determine the prevalence of information quality (IQ) issue and influence of organisation structure and size on asset information quality in facilities management industry	Quantitative
3	To identify the information quality (IQ) attributes specific to asset management (AM) in facilities management operations (FM)	Qualitative
4	To classify the information quality (IQ) attributes into specific information quality (IQ) dimensions within the context of asset management (AM) in facilities management (FM)	Quantitative
5	Develop and evaluate a framework to improve information quality (IQ) of asset management (AM) activities in facilities management (FM) through expert groups	Quantitative

This further provides the justification for the adopted research method – exploratory sequential mixed method strategy (see section 3.3) – which involves integrating qualitative and quantitative data in the research study (Bryman, 2008; Creswell, 2014). This is presented in Figure 3:4. Exploratory studies seeks to find out how people interact in the setting under investigation, what meanings they give to their actions, and what issues concern them (Schutt, 2012). This is predominantly inductive as it seeks to develop theory from the observed phenomenon (Schutt, 2012).

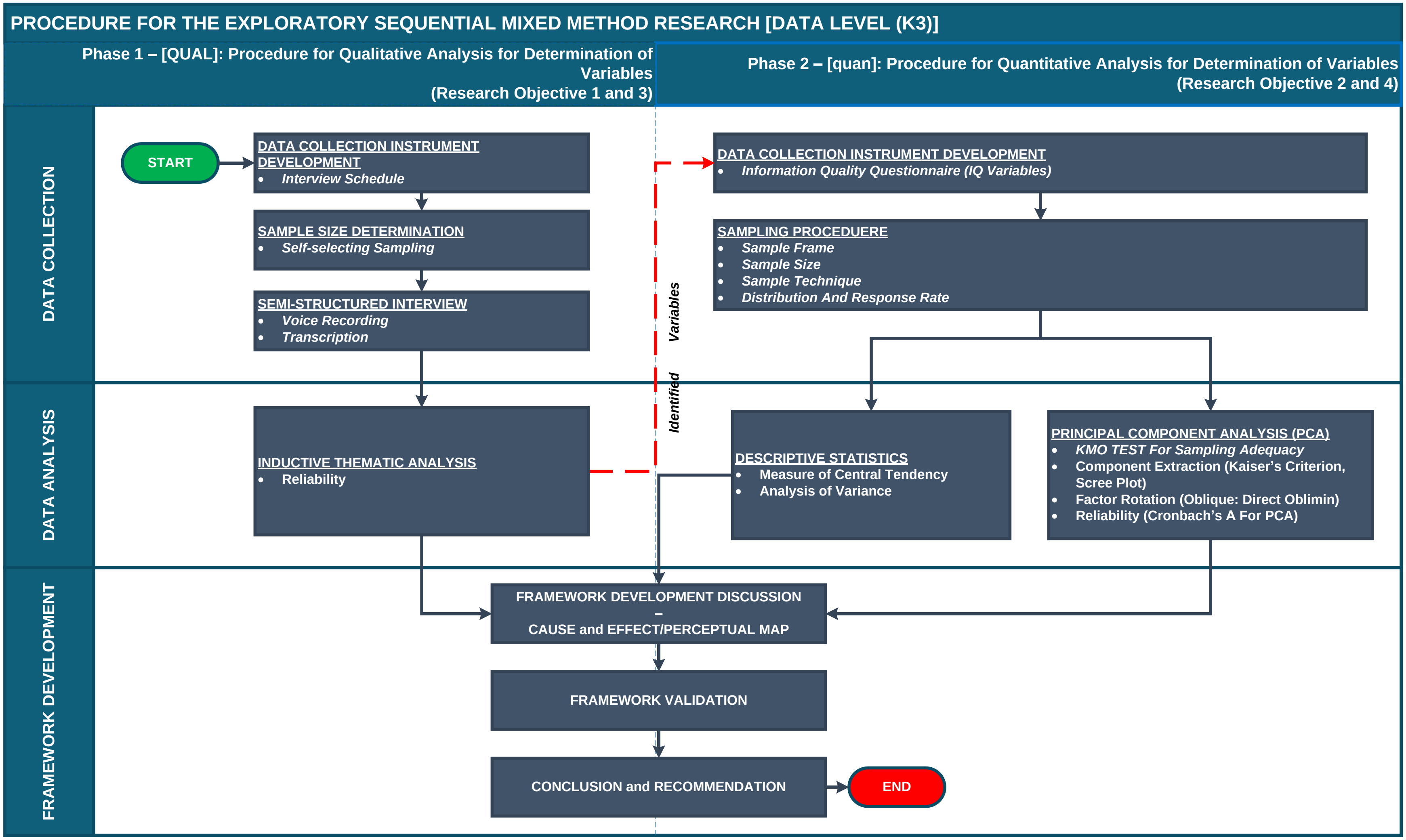


Figure 3:4 Exploratory Sequential Mixed Method Procedure

The rationale for this approach is premised on the fact that more than one phase of the data collection and analysis, involving a qualitative and quantitative phase respectively, will be conducted to accomplish each objective sequentially (Figure 3:4). This is further supported by Amaratunga et al., (2002) who suggested that quantitative and qualitative research should be viewed as complimentary and therefore mixed in research of any kind. The process will begin with the qualitative research phase to explore the views of the participants relating to information quality where research objectives 1 and 3 will be attained (Figure 3:4). The collated data will subsequently be analysed, of which the results shall be built into a second quantitative phase to attain research objectives 2 and 4 (Figure 3:4). This approach allows fine tuning of the research study by specifying the variables that needs to be investigated and develop instruments that best fits the sample under consideration (Creswell, 2014). In addition to this, it is consistent with the approach adopted in BE research (Amaratunga, Baldry, et al., 2002; Kulatunga, Amaratunga, & Haigh, 2004). The sampling strategies applied in the mixed method involve the selection of units for a research study using both probability sampling (to increase external validity) and purposive sampling strategies (to increase transferability) (Teddlie & Yu, 2007).

3.5 Phase 1 - Qualitative Method

Phase 1 represents the qualitative phase whereby qualitative data collection and analysis are performed to obtain relevant variables to be used in the development of measurement instruments which subsequently builds into the quantitative (supporting) phase (Phase 2).

According to McClave & Sincich (2000), qualitative research aims to collect qualitative data. Thus, qualitative method relies on text data rather than numerical data, and analyses those data in their textual form (Saunders et al., 2012). These data cannot be measured on a natural numeric scale and can only be classified into one of a group of categories. It seeks to asks open questions about phenomena as they occur in context rather than setting out to test predetermined hypotheses (Carter & Little, 2007). Researchers use qualitative data to help clarify assumptions, beliefs, attitudes and motivations, which is often a first step as it enables a researcher to fine-tune the language that will be used in quantitative tools (Eisenhardt, 1989). Examples of these methods include interview, observation, and document analysis. Qualitative methods concentrate on exploring in greater depth the nature and origins of people's viewpoints, or the reasons for and consequences of the choices (Easterby-Smith et al., 2001).

3.5.1 Data Collection

Data collection for this phase occurs in three steps, which begins with (1) data collection instrument development (2) sample size determination, and (3) semi-structured interview. It is, therefore, important in this situation not only to use the appropriate technique to achieve the goal of the study but to elaborate on the appropriateness of the techniques used. Though this component will be discussed independently, it should be considered as a whole.

3.5.2 Data Collection Instrument Development

Developing the right instrument is important for effective data collection (Saunders et al., 2012), as such the first process in this phase of the study, is the design of the semi-structured interview schedule. Creswell, (2014) recommended the development of an interview schedule for asking questions and recording answers during a qualitative interview. The interview schedule further acts as the procedural guide and includes a script of what should be said before the interview, what should be said at the conclusion of the interview, and prompts that serves as a reminder for collecting important information (Jacob & Furgerson, 2012).

A robust interview schedule requires a clearly articulated problem to be addressed (McNamara, 2006). Identifying the problem entails the comprehensive synthesis of existing literature within the domain of study based on the research questions and research objectives (Bryman, 2008; Jacob & Furgerson, 2012). According to Bryman, (2008) synthesising the literature helps the development of themes and narrows the focus of the study to important issues. This produces an output consisting a list of themes and key questions to be covered during the interview process (Creswell, 2014).

Turner, (2010) noted that interview schedule provide in-depth information pertaining to participants' experiences and viewpoints of a particular topic. Having an interview schedule helps to obtain thick, rich data utilising a qualitative investigational perspective (Turner, 2010). This supports the qualitative phase of this research (Figure 3:4). Four types of interview schedule have been summarised by Turner, (2010) and McNamara, (2006) and are presented in Table 3:6 which shows their strength and weaknesses, and their application.

Based on the evidence provided above for each interview schedule, this study adopts the general interview guide approach. The use of this technique is relevant as it enables the collection of specific contextual information. It is particularly useful in exploratory studies where the design adopts an inductive approach (Turner, 2010). The design of the interview schedule is based on the recommended structure of Creswell, (2014) constituting the following parts:

1. A heading showing the place, interviewer, and interviewee
2. Instructions for the interviewer to follow permitting consistency across interviews
3. The questions consisting and ice breaker questions and five questions with subsections
4. Probes for each question to elicit further explanation of an idea, statement or concept
5. Spaces between questions to record responses
6. A closing remark acknowledging the interviewee assistance

Table 3:6 Interview Schedule Types (McNamara, 2006; Turner, 2010)

Interview Schedule	Description	Interview Type	Strengths	Weaknesses
Informal Conversational	This is an unstructured approach, which relies on the spontaneous generation of question in a natural interaction. The researcher does not ask specific questions but depend on the collaboration with participants to guide the interview process. No predetermined questions are asked, in order to remain as open and adaptable as possible to the interviewee's nature and priorities	Unstructured Interview	This allows for flexibility in the data collection process and permits deeper understanding of the social setting	Unstable due to inconsistencies in the interview questions making it difficult to code data
General Interview Guide Approach	This approach is more structured but permits flexibility in its composition. It provides more focus than the conversational approach and ensures the same general areas of information are collected from each interviewee	Semi-Structured Interview	Permits follow-up or probing questions based on responses to pre-constructed questions. Allows a degree of freedom and adaptability in getting information from the interviewee	Lack of consistency in the way research questions are posed leading to inconsistent responses across different respondents
Standardized Open-Ended	This is a structured approach where participants are asked identical questions. However, the questions are worded to elicit open-ended responses	Structured Interview	Permits probing questions and reduces researchers biases	Difficulty with coding data and extracting similar themes
Closed, Fixed-Response Interview	Interviewees are asked the same questions and requested to choose answers from among the same set of alternatives. This format is useful for those not practised in interviewing	Structured Interview	Permits easy and quick data coding and extraction of themes	Does not permit probing questions and limits the responses provided by the respondent

3.5.3 Sample Size Determination

This phase of the study utilises non-probability sampling. In qualitative studies, non-probability sampling methods are the dominant sampling method used for selecting the appropriate sample elements for the research (Bryman, 2008; Saunders et al., 2012; Schutt, 2012). According to Saunders et al., (2012) selecting a sample to study should represent the full set of elements[8] from a population in a way that is meaningful and can be justified. However, in qualitative studies, the samples are selected to serve an investigative purpose rather than to be statistically representative of a population (Carter & Little, 2007). Schutt, (2012) acknowledges that this approach is useful when the research question calls for a concentrated investigation of a small population or in an exploratory study.

A range of alternative techniques to select samples in non-probability sampling have been put forward, the majority of which include an element of subjective judgement (Table 3:7) (Saunders et al., 2012; Schutt, 2012).

Table 3:7 Non-Probability Sampling Techniques (Saunders et al., 2012; Schutt, 2012)

Sampling Technique	Description
Quota sampling	The elements are selected to ensure that the sample represents certain characteristics in proportion to their prevalence in the population
Purposive sampling	The elements are selected for a purpose because of their unique position
Snowball sampling	Sample elements are selected as they are identified by successive informants of interviewees
Convenience sampling	This is a form of haphazard sampling procedure in which cases are selected on the basis that they are easiest to obtain
Availability sampling	Sampling based on the availability of elements of the population
Self-selection sampling	This is based on elements within the population identifying their desire to take part in the research usually after the case for the research is publicised and requesting their participation

Saunders et al., (2012) noted that no strict rules exist for non-probability sampling. However, the choice is dependent on the nature of the research (Schutt, 2012).

[8] Elements are the individual members of the population whose characteristics are to be measured (Schutt, 2012)

Saunders et al., (2012) further provide a suggestion for the minimum non-probability sample size for qualitative studies (Table 3:8). The logical relationship between sample selection technique and the purpose of the research is important whereby generalisation are made to theory rather than about a population (Saunders et al., 2012).

Table 3:8 Sample Size for Qualitative Research

Nature of study	Minimum sample size
Exploratory studies	5-25
Ethnographic studies	35-36
Grounded theory	20-35
Case study	12-30

Creswell, (2014) posits that the sample size for the qualitative phase of the research should be small to inform the development of variables for further investigation. Saunders et al., (2012) provides a process criterion for selecting the appropriate sampling technique for an exploratory study. According to Saunders et al., (2012) in a situation where the study is predominantly exploratory and individual elements are not difficult to identify, the use of self-selecting sampling techniques is recommended. To this end, self-selecting sampling technique has been adopted in this phase of the research with a sample size of 10. The self-selection sampling technique is a volunteer sample method that allows the participants to identify their desire to take part in the research study (Saunders et al., 2012). This satisfies the conditions posited by Saunders et al., (2012), Creswell, (2014), and Schutt, (2012).

3.5.4 Semi-Structured Interview

Interviews are extensively used qualitative method in BE research (Amaratunga, Baldry, et al., 2002). The process is a purposeful conversation between two or more people where the researcher is required to establish rapport, ask concise and unambiguous questions, with the intention of eliciting valid and reliable responses from the respondent (Bryman, 2008; Saunders et al., 2012). Easterby-Smith et al., (2001) posits that the primary purpose of interview is to understand the meanings interviewees attach to issues and situations in context. According to Amaratunga et al., (2002), the purpose of the interview is to gather description of the life-world of the interviewee with respect to interpretation of the meaning of the described phenomena. Easterby-Smith et al., (2001) goes further to state that it is an opportunity for the researcher to probe deeply to uncover new clues, open up new dimensions of a problem, and secure vivid accounts that are based on personal experience.

Interviews lie on a continuum of where they can be highly structured and formalised to very unstructured (Figure 3:5) (Easterby-Smith et al., 2001).

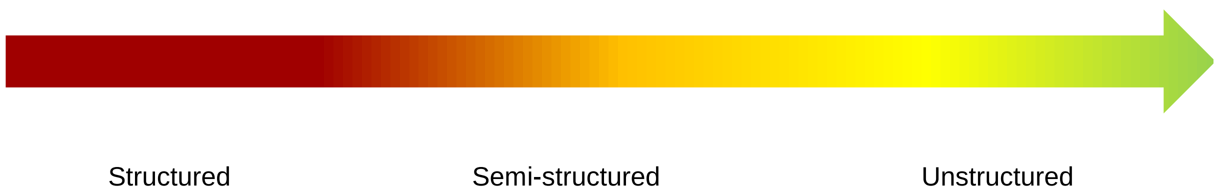


Figure 3:5 Continuum of Interviews Styles

Based on this, three broad types of interview techniques can be used: the structured, the semi-structured, and unstructured (Bryman, 2008; Grix, 2001). Structured interview is the main form of interview used in survey research (Bryman, 2008). They are based on a carefully prepared sets of questions with the assumption that the interviewer will ask each interviewee the same question in the same voice tone (Easterby-Smith et al., 2001). The aim of structured interview is to achieve consistency that enables the replies to be aggregated for statistical analysis (Bryman, 2008). Thus, it is closely linked to the quantitative strand of research. Semi-structured interviews is a qualitative interview technique that permits flexibility of the interviewer in capturing respondent views on issues based on a set of themes (Saunders et al., 2012). Saunders et al., (2012) and Easterby-Smith et al., (2001) agreed that this approach may be used in exploratory studies where step-by-step logic is not clear. Petty, Thomson, & Stew, (2012) further reports on the extensive use of semi-structured interviews in exploratory studies. It permits the elicitation of in-depth responses via the use of probing questions to clarify or expand on a response (Bryman, 2008). Unstructured interviews are loosely structured and informally conducted interview that may commence with one or more themes to explore with participants but without a predetermined list of questions to work through (Saunders et al., 2012).

From the explanation provided above, the nature of the interview should be consistent with the research question, objectives, and methodology (Saunders et al., 2012) making it possible to understand the construct the interviewee uses as a basis of opinions and beliefs (Easterby-Smith et al., 2001). Therefore the semi-structured interview style is adopted for this research, the rationale being it permits a certain degree of flexibility and allows for the pursuit of unexpected line of enquiry during the interview (Grix, 2001). The data from the respondents are captured using a voice recorder and transcribed verbatim (Bloomberg & Volpe, 2012). This is particularly relevant for the process of analysis and reliability (Braun & Clarke, 2006)

3.5.5 Data Analysis

Approaches to qualitative data analysis involve the identification and coding of themes that appear in text passages (Hruschka et al., 2004). According to Hruschka et al., (2004) coding entails (1) compiling a list of defined codes corresponding to themes observed in a text and (2) judging for each predetermined segment of text whether a specific code is present. This method is akin to an inductive approach to data analysis, which has been adopted in this phase of the study. According to Saunders et al., (2012), this approach is suitable for exploratory studies where data is analysed to develop a theoretical structure to guide subsequent work. Inductive data analysis arrive at conclusions by observing know facts on the ground and feeding them into a theory (Grix, 2001). This approach is embodied within the thematic analytical method. Thematic analysis is a method for identifying, analysing and reporting patterns within data (Braun & Clarke, 2006). The pattern within the data are known as themes and are categorised into codes (Kulatunga et al., 2004). The principle is to identify the occurrence of terms that are implicitly or explicitly related to the concepts under consideration (Kulatunga et al., 2004). This offers an accessible form of analysis that works to reflect reality (Braun & Clarke, 2006).

An inductive approach to thematic analysis means themes identified are strongly linked to the data. This is suitable for exploratory studies as this allows categories and codes to emerge from the text data (Kulatunga et al., 2004). According to Braun & Clarke, (2006), the themes identified may bear little relation to the specific questions that were asked of the participants i.e. the specific research question can evolve through the coding process. Inductive thematic analysis is, therefore, a process of coding the data without trying to fit it into a pre-existing coding preconception, which is suitable for this research.

An important issue in research is that of validity and reliability. According to Amaratunga et al., (2002) validity means a theory, model, concept or category which describes reality with a good fit. This is concerned with the integrity of the conclusions that are generated from a piece of research (Bryman, 2008). Validity, however, is synonymous with quantitative studies (Bryman, 2008; Golafshani, 2003; Hruschka et al., 2004). Hruschka et al., (2004), reports that qualitative inquiry is a distinct paradigm, which should not be judged by the reliability criteria that are derived from positivist, or quantitative paradigms. This view is supported by Bryman, (2008) who argues that there is no absolute truths about the social world as more than one account if the social context can exist.

Thus to reflect a close link to qualitative studies, the term credibility has been adopted (Bloomberg & Volpe, 2012; Bryman, 2008; Golafshani, 2003). Credibility parallels the criterion of validity and refers to whether participants' perceptions match up with the researcher's portrayal of them (Bloomberg & Volpe, 2012). Establishment of credibility entails that research is performed according to the ethical consideration and duly reflect the social world being studied through the process of triangulation (Bryman, 2008). Therefore to achieve credibility in this study, an accurate representation and quantification of what the participants think, feel, and do is achieved using the methods of data collection, capture i.e. voice recording and verbatim transcription, and triangulation that provide incremental validity to thematic analyses (Bloomberg & Volpe, 2012; Braun & Clarke, 2006; Onwuegbuzie & Leech, 2005).

3.6 Phase 2 - Quantitative Method

Phase 2 represents the quantitative phase whereby quantitative data collection and analysis are performed to buttress the qualitative phase (Phase 1). The quantitative method of this research relies on statistical or numeric inferences to determine the relevant dimensions of IQ and the effect of organisation size or structure on IQ. According to McClave & Sincich (2000), quantitative data are measurements that are recorded on a naturally occurring numerical scale which involves collecting, classifying, summarising, organising, analysing, and interpreting numerical information. Quantitative method uses random sampling procedures which is based on statistical theory (Bloomberg & Volpe, 2012). Random sampling controls for selection bias and enables generalisation from the sample to a larger population (Bloomberg & Volpe, 2012).

With specific reference to this study, the quantitative phase is aimed at determining the latent constructs that account for the characteristics of the observed variables (Field, 2013; McClave & Sincich, 2000; J. Pallant, 2013) whereby reducing them to specific dimensions and providing an interpretation of the observed events is the key priority (Easterby-Smith et al., 2001). The analytical procedures adopted for this phase of the research are principal component analysis (PCA) and analysis of variance (ANOVA). These are exploratory techniques used to describe the components observed (Field, 2013). Components are assumed to reflect underlying processes that have created correlations among variables (Tabachnick & Fidell, 2012). The following sections explain the sequence of this phase and provide the rationale for the adopted techniques.

3.6.1 Data Collection

Data collection for this phase is based on the analytical procedure performed for the research. Two steps are implemented in this section that begins with (1) data collection instrument development, and (2) sampling procedure. It is, therefore, important in this situation not only to use the appropriate technique to achieve the goal of the study but to elaborate on the appropriateness of the techniques used. Though this component will be discussed independently, it should be considered as a whole.

3.6.1.A Data Collection Instrument Development

As indicated from the previous section, exploratory sequential mixed method begins with the qualitative phase of which the aim is to explore and specify explicit themes used to build an instrument that best fits the sample under consideration (Creswell, 2014). According to Creswell, (2014) specific variables identified from the qualitative phase are measured in the quantitative phase. To enable this measurement, the variables are built into a questionnaire which reliably operationalise the key concepts detailed within the research questions and objective (Rattray & Jones, 2007).

The use of questionnaires in research have been acknowledged to be effective techniques in accumulating data from a determined population (Burgess, 2001; Rattray & Jones, 2007; Saunders et al., 2012). Saunders et al., (2012) refers to questionnaires as a method of data collection in which each respondent is asked to reply to the same set of questions in a predetermined order. The utility of the questionnaire i.e. the response rate, reliability, and validity, is further influenced by the design of the questionnaire (Saunders et al., 2012). Thus, to be valid, the design and development must be supported by a logical, systematic, and structured approach (Rattray & Jones, 2007). This allows the collection of information in a standardised manner and enables inference of results to the wider population (Rattray & Jones, 2007). The following steps have been applied in developing the questionnaire used in this study (Burgess, 2001; Saunders et al., 2012):

1. Careful design of questions and question type based on result from the qualitative phase and literature
2. Clear layout and sequence of questions
3. Detailed explanation of the purpose of the questionnaire
4. Pilot testing
5. Planned and executed delivery and return of completed questionnaire

Collection of data in a standardised manner takes the form of a scaled measurement. Several types of scale measurement can be applied to a questionnaire (Albaum, 1997; Rattray & Jones, 2007). However, this research adopts the Likert-type scale method where each variable is represented as a row that contains the appropriate numeric code (Burgess, 2001). Likert-type scales use fixed choice response formats designed to measure attitudes or opinions (Rattray & Jones, 2007). They make use of ordinal data to measure levels of agreement or disagreement in a linear way i.e. on a continuum, from strongly agree to strongly disagree (Rattray & Jones, 2007). The questionnaire designed for this research uses a nine (9) point and five (5) point Likert scale that measures the prevalence of information quality issues and level of importance of the information quality attribute. This approach has a neutral point where the respondent has the ability "sit on the fence" with the aim of decreasing non-response bias (Rattray & Jones, 2007; Saunders et al., 2012).

3.6.1.B Sampling Procedure

The approach to sampling used in this phase of the research is probability-based which refers to a method of selecting samples such that the probability of being included in the sample is known for every unit in the sampling frame (USEPA, 2002). Probability sampling is based on underlying theoretical distributions of observations, or sampling distributions (Teddlie & Yu, 2007). Though several sampling techniques have been identified and used in probability sampling, this research will focus on three probability sampling techniques that have the potential to be applied seamlessly to this study (Saunders et al., 2012; Teddlie & Yu, 2007; USEPA, 2000, 2002). These include simple random sampling, systematic random sampling, and stratified sampling and shall be discussed respectively.

B.1 Simple Random Sampling

Involves selecting samples at random from the sampling frame using a random number algorithm where which each unit in the accessible population is assigned a random number and has an equal chance of being included in the sample (Saunders et al., 2012; Teddlie & Yu, 2007). The use of random numbers allow the sample to be selected without bias thereby ensuring the sample is representative of the population (Saunders et al., 2012). The probability of a unit being selected is not affected by the selection of other units from the accessible population (Teddlie & Yu, 2007). However, caution needs to be considered when using this approach as this may lead to parts of the population being over or under represented (Saunders et al., 2012, p. 274)

B.2 Systematic Random

This entails selecting the sample at regular intervals from the sampling frame based on a calculated sampling fraction (Saunders et al., 2012). The initial sampling point is chosen at random, and the remaining sampling points are specified so that they are located according to a regular pattern (USEPA, 2002). The sampling points are located in a deterministic way relative to that starting point (USEPA, 2000). This approach does have the potential to introduce a level of bias, based on its uniform pattern of sampling points, into the sampling procedure as forces every n^{th} item to be selected from the frame (Saunders et al., 2012; USEPA, 2000). It, therefore, should be used with caution whenever there is a possibility of some type of cyclical pattern in the process (USEPA, 2000).

B.3 Stratified Sampling

In stratified sampling, each unit within the population belongs to a single stratum, which facilitates the selection of units from those strata with similar characteristics (Saunders et al., 2012). Based on this, the population is divided into subgroups known as strata (Teddlie & Yu, 2007). The aim of this method is to achieve representativeness of the population based on some characteristic of interest identified within the population (Teddlie & Yu, 2007). This is followed by a random sample being taken from each strata with the view of making the sample more representative (Saunders et al., 2012; USEPA, 2006). Dividing the population into relevant strata implies that the sample is more likely to be representative as each strata is proportionally represented within the sample (Saunders et al., 2012). However, this approach often lead to sampling complexity where there are more subgroups in the sample that needs to be represented (Teddlie & Yu, 2007)

3.6.2 Selected Sampling Method and Sample Size Determination

This section discusses the sampling size, sample frame, and sampling technique that have been adopted in this study. The analytical procedures[9] [10] [11] adopted in this phase necessitates the specific determination of the right sample size to elicit valid result (Saunders et al., 2012, p. 265). Creswell, (2014) recommends that the sample of the quantitative phase should excluded the elements selected in the qualitative phase to avoid undue duplication of responses. Several methods for sample size determination have been suggested by several authors (Bartlett, Kotrlik, & Higgins, 2001; Krejcie & Morgan, 1970; McClave & Sincich, 2000; Saunders et al., 2012). These methods involve the use empirical techniques to estimate the optimal sample size to be studied. A significant consideration is the acceptable margin of error that can be tolerated within the study. These errors include alpha errors and beta errors (Bartlett et al., 2001). Alpha errors refer to a situation that results in finding a difference that does not actually exist in the population, while beta error results in failing to find a difference that actually exist in the population (Bartlett et al., 2001). Effective sampling takes into consideration these errors and non-response bias and tries to minimise them accordingly (Bartlett et al., 2001; Krejcie & Morgan, 1970). The margin of error used in this research specifies the degree of accuracy of the results obtained from the sample and asserts a probability that the result from the sample approximates the number that would be derived if the whole population is queried (McClave & Sincich, 2000). Thus using an adequate sample will result in more reliable, valid, and generalizable results (Bartlett et al., 2001). This study uses the formula provided by Krejcie & Morgan, (1970) in calculating the appropriate sample size to be used (Equation 3:1).

[9] Analysis of Variance (ANOVA)
[10] Measure of Central Tendency (MCT)
[11] Principal Component Analysis (PCA)

$$s = \frac{X^2 NP(1-P)}{d^2(N-1) + X^2P(1-P)}$$ Equation 3:1 Sample Size (Krejcie & Morgan, 1970)

Where:

1. X^2 = the table value of chi-square for 1 degree of freedom at the desired confidence level (95%)
2. *N* = the population size (determined from the sample frame)
3. *P* = the population proportion (assumed to be .50 (50%))
4. *d* = margin of error - the degree of accuracy at 95% confidence level
5. *s* = required sample size

As discussed in the preceding sections, it is important to select the appropriate sampling procedure that will guarantee a reliable inference of the result. To this end, a simple random probability sampling has been adopted in this phase (Bryman & Cramer, 2004). As indicated in Subsection B.1 this approach involves selecting samples at random from a sampling frame using a random number algorithm where which each unit in the accessible population has an equal chance of being included in the sample (Saunders et al., 2012; Teddlie & Yu, 2007). The use of random numbers allow the sample to be selected without bias thereby ensuring the sample is representative of the population (Saunders et al., 2012). The sampling frame used for this phase was obtained from the database of organisations within the facilities management industry (BvD Fame, 2013; Saunders et al., 2012).

3.6.3 Response rate

The response rate refers to the proportion of people from the sample who will respond to the questionnaire or from which data will be collected (Saunders et al., 2012). Bartlett et al., (2001) posits that determining the response rate is not a precise science and recommended the use of oversampling methods to determine the anticipated response rate for a survey. These include:

1. Taking the sample in two steps and using the results of the first step to estimate how many additional responses may be expected from the second step
2. Using pilot study results
3. Using responses rates from previous studies of the same or a similar population
4. Estimating the response rate

Section 5.2.4 provides a detail discussion on the determination of the response rate used in this research. The next section discusses the data analysis stream where the specific procedures adopted in this study are elucidated.

3.6.4 Data Analysis

This section of the data analysis presents the methods used in the quantitative analysis of the data. Figure 3:4 presents two (2) adopted method used in the analysis of the quantitative data. These are descriptive statistics and principal component analysis. The selection of these methods of analysis is premised on the nature of the research and its objective. As indicated from the preceding sections, this research adopts an exploratory approach in investigating the phenomenon, as such, these methods of analysis have been identified to be suitable for exploratory studies (Tabachnick & Fidell, 2012). The succeeding section presents a discussion of these methods.

3.6.4.A Descriptive Statistics

This section presents the rationale for the use of descriptive statistics in this research. All research endeavour seeks to identify patterns in data to make useful conclusions about what is being observed. This is accomplished by utilising descriptive techniques in research studies. Fellows & Liu, (2003) noted that a descriptive statistics approach systematically identifies and records a phenomenon from a particular perspective to enable the subject matter to be categorised. According to McClave & Sincich, (2000) descriptive statistics performs three (3) distinct functions: (1) it look for patterns in a data set by utilising numerical and graphical methods, (2) aids in summarising the information revealed in a data set, and (3) present the information in a convenient form. In addition to this J. Pallant, (2013) noted that by using descriptive statistics, a researcher is able to describe the characteristics of a sample used in a research. J. Pallant, (2013) goes further in highlighting the importance of checking data variables in order not to violate specific assumptions underlying a statistical technique such as ANOVA. The testing of assumptions is achieved by obtaining the following descriptive statistics on the variables being examined: mean, median, standard deviation, range of scores, skewness, and kurtosis (J. Pallant, 2013). Collectively these statistics are known as measure of central tendency.

The next section discusses the application of the analysis of variance (ANOVA) in this study which utilises the measures of central tendency.

3.6.4.B Analysis of Variance (ANOVA)

ANOVA is a method that enables the comparison of mean scores of more than two groups (J. Pallant, 2013). It is a parametric statistics which assumes that the underlying distribution of scores in the population from which the sample is taken is normal (J. Pallant, 2013). McClave & Sincich, (2000) states that ANOVA facilitates the comparisons of two or more populations based on independent random samples. Fellows & Liu, (2003) opined that ANOVA is a systematic approach which identifies the constituents of the total variation in a sample thereby apportioning the total variation to the contributing sources. This approach is used in testing the significance of difference between two or more sample means (Fellows & Liu, 2003).

Two methods of ANOVA have been applied in this study to determine the effect of a factor in the quality of information. These methods are One-Way ANOVA and Factorial-ANOVA (Field, 2013; J. Pallant, 2013). One-way ANOVA involves one independent variable having a number of different levels while factorial-ANOVA involves determining the effect of two or more independent variables or predictors on a dependent variable (Field, 2013; J. Pallant, 2013). The procedure for implementing ANOVA is presented in Figure 3:6. Section 5.5.2 and 5.5.3 provides a detail explanation of the implementation process for ANOVA.

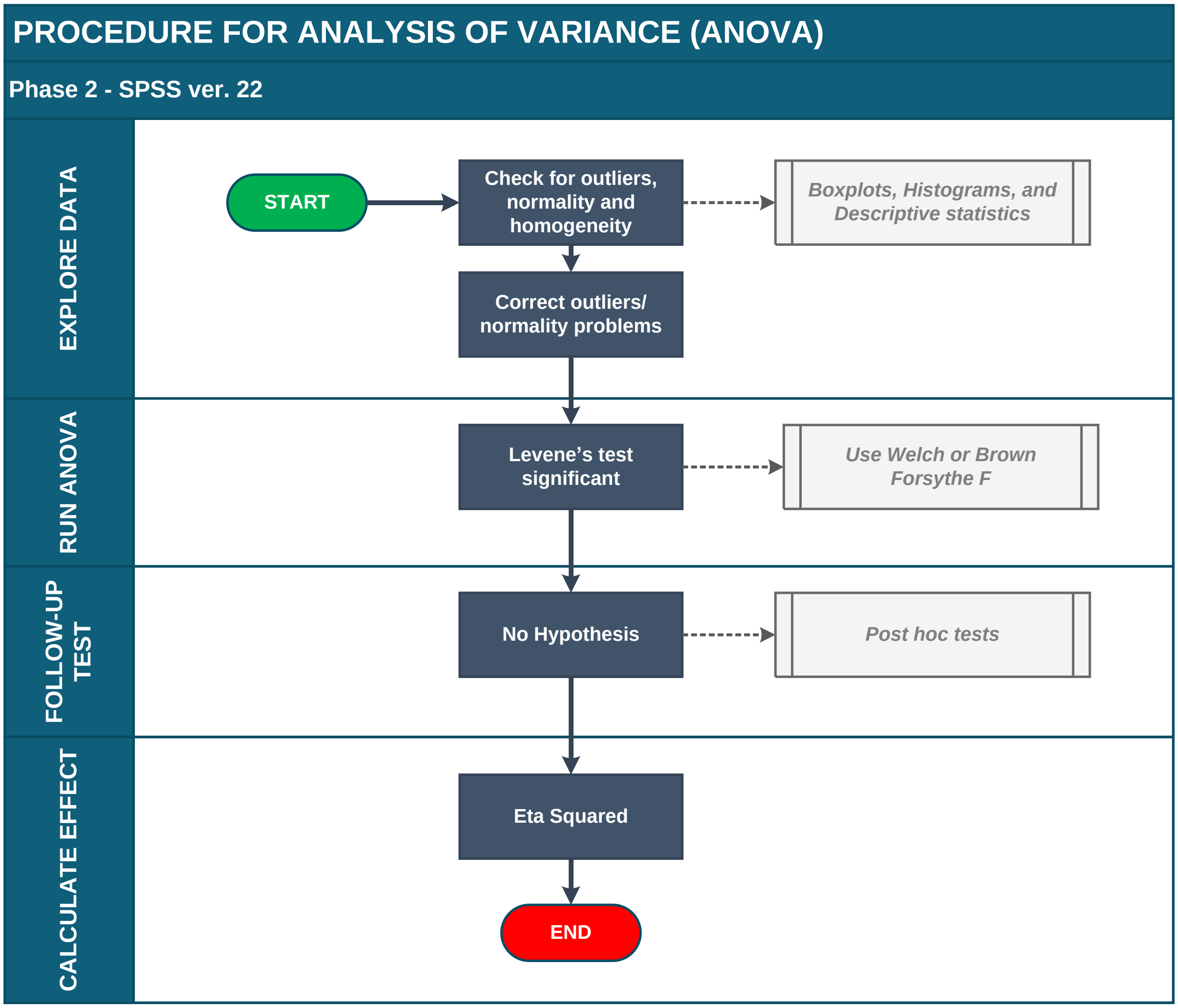


Figure 3:6 Procedural approach for ANOVA

3.6.4.C Principal Component Analysis (PCA) - Component Extraction

Tabachnick & Fidell, (2012) elucidates the goals of PCA to be (1) to summarize patterns of correlations among observed variables, (2) to reduce a large number of observed variables to a smaller number of factors, (3) to provide an operational definition for an underlying process by using observed variables, (4) to test a theory about the nature of underlying processes. Interpretation of identified components using PCA is researcher driven based on the underlying theory and literature (J. Pallant, 2013). The procedure for this approach is depicted in Figure 3:7 and discussed in the succeeding sections.

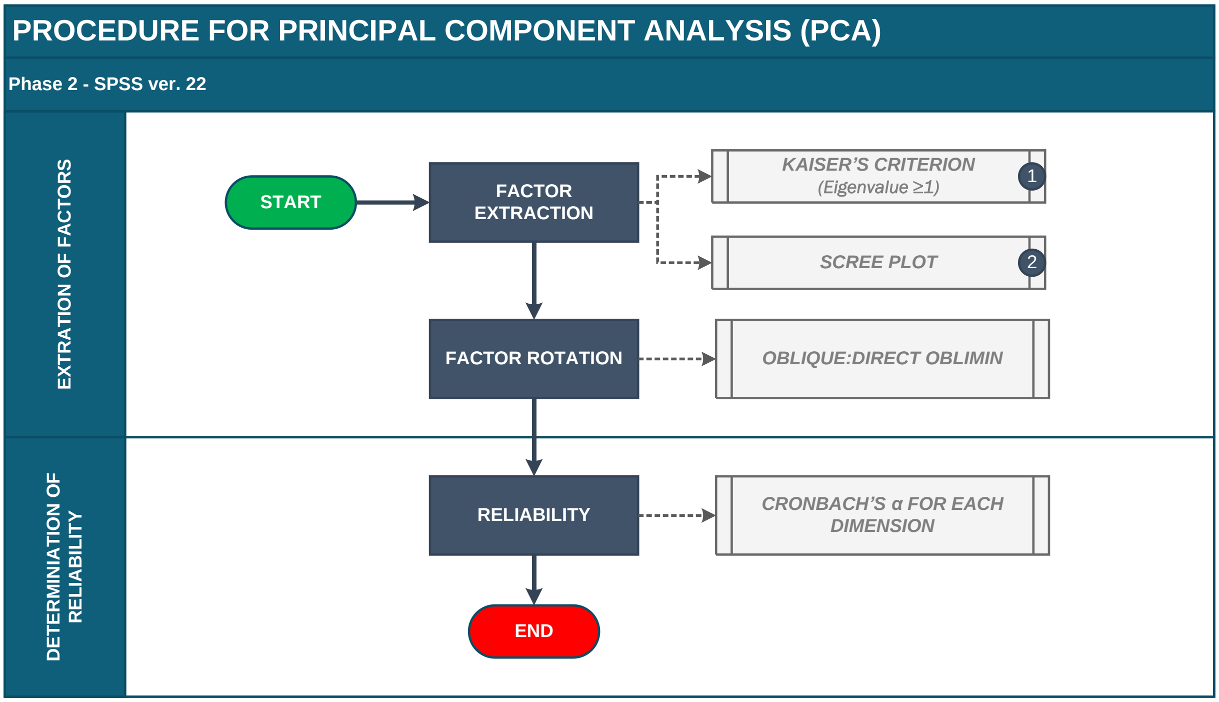


Figure 3:7 Procedural Approach for PCA

C.1 Factor Extraction

The purpose of PCA is to reduce a large number of related measured variables into a smaller set of components that accounts for the measured variables (Field, 2013; J. Pallant, 2013). Based on this, component extraction involves determining the smallest number of factors that can be used to represents the interrelationships among the set of variables (J. Pallant, 2013). The process of deciding how many component to extract and keep is called extraction (Field, 2013). According to J. Pallant, (2013) the number of extracted components determined best describes the underlying relationships among the variables. Kaiser's criterion and scree test are the main methods used to decide upon the number of component to retain from the analysis (Rattray & Jones, 2007). These methods have been actively adopted and implemented in this research.

Kaiser's criterion is based on retaining components with associated eigenvalues greater that one (1.0) (Field, 2013). Eigenvalues of a component represents the amount of the total variance explained by that component (Floyd & Widaman, 1995; J. Pallant, 2013). It should be noted that this approach results in retention of too many components thus a further approach is needed to determine the best number of components to retain. The scree test is used to solve this problem (Floyd & Widaman, 1995). The scree test involves plotting each eigenvalues of the un-rotated component on a coordinate plane and examining the point where the slope of the curve approaches zero (point of inflexion) (Floyd & Widaman, 1995; J. Pallant, 2013). The point of inflexion, where the slope of the line becomes horizontal, is determined as the cutoff and components above this points are retained (Field, 2013). With principal components analysis, the scree test usually produces cutoffs near eigenvalue = 1.00 (Floyd & Widaman, 1995). According to Floyd & Widaman, (1995) this indicates a point at which deleting a given factor would no longer result in discarding significant variance.

C.2 Factor Rotation

An important aspect of PCA is the interpretation and naming of identified components. Interpretation and naming of components depend on the meaning of the particular combination of observed variables that correlate highly with other component (Tabachnick & Fidell, 2012). To this end factor rotation is used to improve the interpretation and scientific utility of the retained components (Tabachnick & Fidell, 2012). The aim is to determine variables that loads highly on as few components as possible leading to simple structure[12] (Floyd & Widaman, 1995).

Factor rotation effectively rotates the axes on which the variables are plotted such that the variables are loaded maximally to only one component (Field, 2013). By using factor rotation, it is easy to identify which variables cluster closely together for ease of interpretation (J. Pallant, 2013). Table 3:9 presents two procedures used in determining the rotation; (1) orthogonal, in which factors are kept uncorrelated, and (2) oblique, in which the factors are allowed to correlate (Floyd & Widaman, 1995). J. Pallant, (2013) argues that orthogonal rotation results in solutions that are easier to interpret but requires the researcher to assume the underlying constructs are independent, while

[12] Simple structure: this involves each of the variables loading strongly on only one component and each component being represented by a number of strongly loading variables (J. Pallant, 2013)

oblique rotation allow for the components to be correlated but presents difficulty in interpretation. Within the broad categories of rotation, there are a number of different techniques provided by SPSS[13] to maximise the outcome of the rotations (Field, 2013; Tabachnick & Fidell, 2012).

Table 3:9 Factor Rotation Technique Procedure

Rotation Category	Rotation Technique	Description
Orthogonal	Varimax	The goal of varimax rotation is to simplify components by maximising the variance of the loadings within components across variables. Interpreting a components is easier because it tries to load a smaller number of variables highly on each component
	Quartimax	Minimise complexity of variables by maximising the spread of component loadings for a variable across all components. Often results in many variables loading highly on a single component
	Equamax	Tries simultaneously to simplify the component and the variables loadings but tends to behave erratically
Oblique	Direct Oblimin	Simplify components by minimising cross-products of loadings
	Promax	Orthogonal factors rotated to oblique positions

This research implements the oblique factor rotation using direct oblimin technique in determining the cluster of variables on each component. This allows the components to correlate as they are not independent construct but exert an influence on the other (Field, 2013).

C.3 Reliability - Cronbach's α For PCA

Reliability statistic represents the final task performed within PCA. Reliability means a measure consistently reflect the construct being measured (Field, 2013). According to Golafshani, (2003) reliability represents the extent to which results are consistent over time. Reliability is based on the indication that individual items would produce results consistent with the overall questionnaire (Field, 2013). Different variants of measuring reliability have been put forward which include external reliability, internal reliability, and split-half reliability (Fellows & Liu, 2003, p. 157). According to Fellows & Liu, (2003), external reliability concerns the consistency of a measure over time measured by re-

[13] SPSS (Statistical Package for the Social Sciences) is a statistics software package used for statistical analysis

test reliability, internal reliability concerns the internal consistency of items which constitute a scale, and while split half reliability examines the consistency of respondent score of when the item in the scale are split into two halves. The internal consistency of items which constitute a scale are best determined using the Cronbach's α statistic (De Vaus, 2002, p. 21). This method is frequently applied in demonstrating reliability in PCA (De Vaus, 2002, p. 21; J. Pallant, 2013; Rattray & Jones, 2007). Rattray & Jones, (2007) indicated that this statistic uses inter-item correlations to determine if constituent items are measuring the same component. De Vaus, (2002) posited that providing the most thorough analysis of patterns of internal consistency is the strength of the Cronbach's α statistic. Accepted values of Cronbach's α statistic for a scale falls between 0.5 and 0.8 (Fellows & Liu, 2003; Field, 2013; J. Pallant, 2013; Rattray & Jones, 2007; Tabachnick & Fidell, 2012)

3.7 Framework Development

Following on from the data analysis is the development of the framework designed to enable FM professional assess the quality of information used in AM activities. This satisfies the aim of the research as presented in Chapter 1 . The framework presents the collection of elements that shall emerge from the analysis. It explains the key factors, constructs, variables, and the relationship among them graphically (Pant & Ravichandran, 2001; Ravitch & Riggan, 2012). Ravitch & Riggan, (2012) argues a framework to be a constructed artefact which incorporates pieces borrowed from other disciplines, whereby the structure and overall coherence is unique to the research and non-existent a priori.

The framework developed by the efforts of this study aims to achieve the following goals as argued by Eppler & Wittig, (2000): (1) to provide a systematic and concise set of criteria by which IQ can be evaluated, (2) to provide a scheme to analyse and solve IQ problems, (3) to provide a basis for proactive IQ measurement and management, and (4) to provide the research community with a conceptual map that can be used to structure a variety of approaches, theories, and IQ related phenomena. To this end, the framework developed in this study is the integration of the identified concepts, which shows the basic relationship to, and influence on asset information quality, which aims to satisfy the goals stated hitherto. It uses the concept of cause-and-effect and the perceptual map for the assessment of IQ in AM programs (discussed below).

3.7.1 Cause-and-Effect Diagram

The first part of the framework development is the formulation of the cause-and-effect structure used to establish the factors influencing asset information quality. The cause-and-effect diagram, often called the Ishikawa diagram or fishbone diagram, provides a powerful tool to analyse and solve problems relating to quality (ASQ, 2015). This tool was developed by Professor Kaoru Ishikawa in the 1950s and was applied to manufacturing problems (Holtz & Campbell, 2004; Juran & Godfrey, 1999). However, Tague, (2005) acknowledged that this tool has been found to be flexible and adaptable, which is seen as a significant advantage over other quality tools, and has been applied successfully in other industries, processes, and problems. Tague, (2005) goes further to state that cause-and-effect diagram can be used to structure a brainstorming session to facilitate the sorting of ideas into useful categories when identifying many possible causes for an effect or problem. This has been found useful in the field of IQ management (Levis et al., 2007; Liu & Chi, 2002; Moody & Shanks, 2003; Sebastian-Coleman, 2013).

The schematic presentation of the cause-and-effect diagram (Figure 3:8) shows the effect (symptom) presented on the arrow tip, and the possible causes (theories) organized into categories, or zones, which are added to the pattern (Juran & Godfrey, 1999).

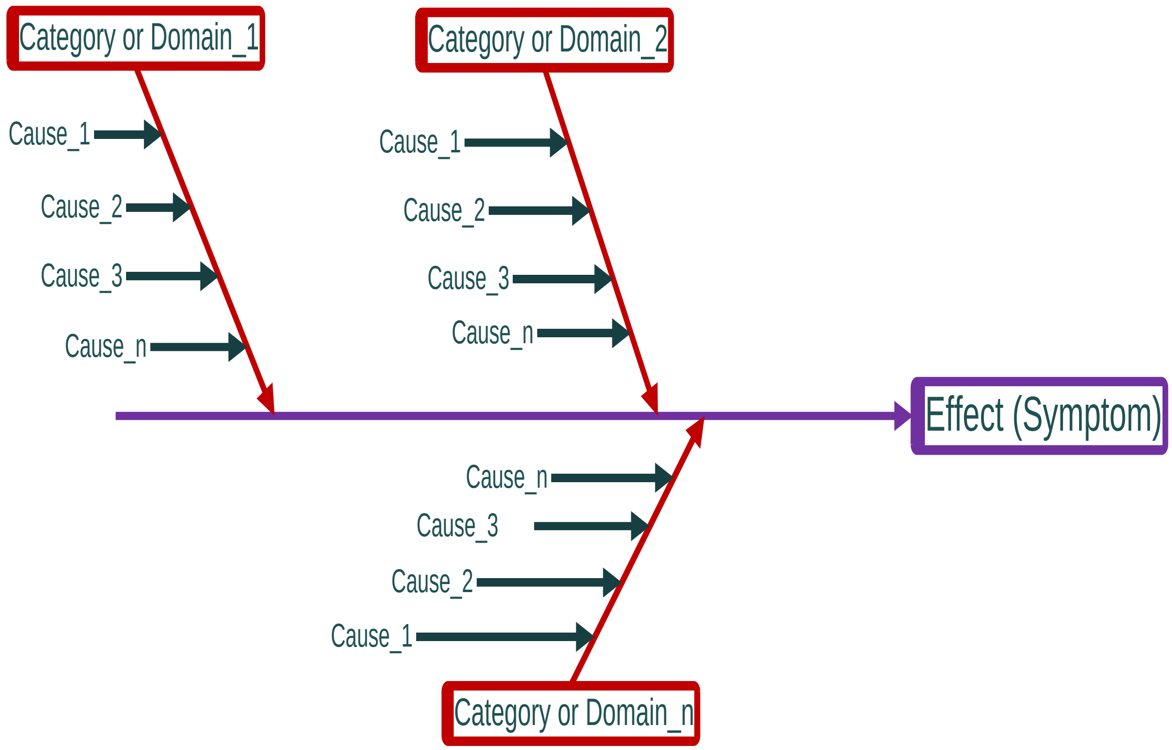


Figure 3:8 Cause-and-Effect Diagram

3.7.2 Perceptual Map

The second part of the framework is the development of the perceptual map (PerMap) to be used in the assessment of IQ of AM programs in FM.

According to Gower et al., (2014) perceptual maps are used to visually study relationships between two or more attributes whereby the attributes, which are grouped together on the perceptual map, are said to be associated (Remenyi, 1992). According to Remenyi, (1992), the association of such attributes may be thought of as a type of correlation which indicates the existence of a relationship[14] between the variables. The perceptual maps are visual representation of peoples' perceptions and preferences, which provides a quantitative illustration of how people perceive different products or

[14] The perceptual map does not indicate the type of relationship.

services in a number of dimensions (Kotler & Keller, 2012). Remenyi, (1992) noted that perceptual map represents the relative positions or grouping of the various concepts listed in a matrix or frequency table. According to Mojtahed et al., (2014) perceptual mapping provides technical intelligence to help organisations understand the vision customers have for their products that compete with similar products by producing graphical representations in a two-dimensional space. This approach adopts an objectivist view in collecting and analysing data on consumers opinion by developing and using attribute-based methods such as factor analysis, similarity based methods such as multi-dimensional scaling (MDS), correspondence analysis, and principal component analysis (Gower et al., 2014; Mojtahed et al., 2014). However, A. J. T. Lee, Yang, Chen, Wang, & Sun, (2016) argues that the ability to display attributes in a two-dimensional space constitutes a weakness in the use of perceptual map. Another shortcoming of the perceptual map, as presented by Adaval, Coupey, & Narayanan, (2015) is the use of subjective determination of the dimensions in the perceptual map. Nonetheless, its simplicity of use, adaptability, and constitution within empirical methods outweighs these shortcomings.

According to Mojtahed et al., (2014) a typical perceptual map feature the following characteristics:

1. Pair-wise distances between product alternatives that indicate how closely related products are according to customer's understanding
2. A vector on the map that geometrically denote attributes of the perceptual map
3. Axes that suggest the underlying dimensions that best characterise how customers differentiate between alternatives

Adaval et al., (2015) separates perceptual maps into two categories: (1) attribute-based, (2) non-attribute based. The first of these uses techniques such as factor analysis to uncover underlying factors while the second uses multidimensional scaling to elicit consumer judgement of products (Adaval et al., 2015). Adaval et al., (2015) further states that important elements which characterised perceptual maps are: (1) the number of dimensions, (2) names of the dimensions, and (3) location of the attributes on the dimensions.

3.8 Chapter Summary

This section presents the summary of the methodology chapter. The principles that have been discussed above shall be revisited with a key focus on the challenges this brings to the research. This study adopts a qualitative research paradigm for the investigation of IQ in AM. As indicated above, the ontological and epistemological position taken are constructivism and interpretivism respectively. These positions present an axiological conundrum for researchers in trying to ensure that a level of objectivity is established. Axiology studies judgements about the role of values and permits the understanding of what values go into knowing what we know (Bloomberg & Volpe, 2012; Saunders et al., 2012). According to Saunders et al., (2012), the axiology adopted by a qualitative researcher is value-laden i.e. the researcher is part of what is being researched, cannot be separated from it, and so will be subjective.

It has been argued that, unlike quantitative research, qualitative research has the tendency to be subjective in its outputs (Bryman, 2008; Carter & Little, 2007). This is an effect caused by the inherent values possessed by the research practitioner or the very nature of what is being studied i.e. information quality and presents a major challenge in such research activities. Values are the preconceptions a researcher possesses that reflects either a personal belief or feeling (Bryman, 2008). This has the tendency to create bias and blur the objectivity in the results of the research. Thus it is important to establish a level of trustworthiness. It has been reported that for qualitative research to be trustworthy, it needs to be value-free (Bloomberg & Volpe, 2012; Bryman, 2008; Carter & Little, 2007). However, this goes against the basic fabric of such research endeavour whereby the researcher tends to immerse himself or herself in the context of the research thus influencing it to an extent (Saunders et al., 2012). Therefore qualitative research is described a value-laden (Healy & Perry, 2000).

The paradigm of qualitative research, as highlighted, tends to introduce bias. In order to minimise this effect, it is important that a criteria for ensuring trustworthiness of the research is adopted. These criteria have been elucidated by Bloomberg and Volpe, (2012), Golafshani, (2003), and (Bryman, 2008) as follows:

1. Credibility: refers to whether the participants' perceptions match up with the researcher's portrayal of them i.e. has the researcher accurately represented what the participants think feel and do?
2. Dependability: refers to whether one can trace the processes and procedures used to collect and interpret data
3. Transferability: refers to the fit or match between the researcher context and other contexts as judged by the reader i.e. how well the outcomes of the research will fit similar contexts as judged by the reader

In order to meet the criteria for evaluating trustworthiness outlined by Bloomberg and Volpe, (2012), data triangulation will be adopted. Triangulation is a procedure that draws on multiple perceptions or data sources to clarify meaning (Bloomberg & Volpe, 2012; Bryman, 2008). It has been described as a test for improving the validity and reliability of research or evaluation of findings (Golafshani, 2003). The goal is to limit the chances of bias in the methods or sources employed (Grix, 2001). Amaratunga et al., (2002) indicated that triangulation is the combination of methodologies in the study of the same phenomenon. According to Bryman, (2008) triangulation can operate within and across strategies to develop measures resulting in greater confidence in findings. The assumption made in triangulation is that effectiveness of research findings rests on the premise that the weaknesses in each single method used is compensated by the strengths of the other method used (Amaratunga, Baldry, et al., 2002). Therefore, this implies that triangulation is affiliated to mixed-methods research (Amaratunga, Baldry, et al., 2002) which has been adopted in this study.

Barbour, (2001) argues that though triangulation is used to confirm or refute the internal validity of research by corroborating or refining finding, the adoption does not in itself confer rigour if adopted without thorough, and clear justification. Therefore, a robust theoretical and methodological approach that incorporates multiple sources of information, models and methods in a study to adequately inform knowledge is required (Korte, 2009). This involves the combination of the use of theory, literature, and respondent validation (Amaratunga, Baldry, et al., 2002; Bryman, 2008). This approach is forthwith applied in the context of this research. The succeeding chapter presents the analysis of data using the identified techniques.

Chapter 4 Qualitative Data Analysis – Phase 1

This chapter presents the analysis of the interviews within the organisations whereby findings arrived at are discussed in detail. This section is achieved by the qualitative analysis which provides both identification and evaluation of several factors that influence information quality within the context of AM programs in FM operations. This seeks to achieve objective one (1) and three (3) of the research (see Section 1.3).

The sampling approach adopted for this phase was based on a non-probabilistic sampling technique strategy (see Section 3.5.3 for a detailed discussion). Non-probabilistic sampling, in contrast to probabilistic sampling, is used to enable the selection of information-rich cases for in-depth study where the size and specific cases depend on study purpose (Then, 1996). This approach is regarded to be more suitable for in-depth qualitative research in which the focus is often to understand complex social phenomena (Creswell, 2014). For this study, the unit of analysis chosen was the facilities management organisation. Respondents for this research were staff of the organisation on the strategic, tactical, and operational levels which included managers and front line staff. Only nine respondents in total from the contacted organisations who agreed to take part in the research, after consents concerning the research was agreed, was analysed. Relevant data was collected on-site via a semi-structured interview.

A participant coding scheme was developed to facilitate the analysis of the responses of the participants and ensure anonymity was fully established. Based on this coding scheme, information about the participants' age range and level within the organisation were gathered and are presented in Table 4:1, Figure 4:1, and Figure 4:2.

Table 4:1 Coding Scheme

S/N	Gender	Age Range	Position	Position Level Code	Position Level	Position Code	Participant Code
1	MALE	41-45	OPERATIONS MANAGER	1	STRATEGIC	OPSMGR	OPSMGR-1
2	FEMALE	26-30	PLANNER	3	OPERATIONAL	PLNR	PLNR-2
3	FEMALE	21-25	PLANNER	3	OPERATIONAL	PLNR	PLNR-3
4	FEMALE	26-30	PLANNER	3	OPERATIONAL	PLNR	PLNR-4
5	MALE	31-35	BID MANAGER	1	STRATEGIC	BDMGR	BDMGR-5
6	MALE	31-35	ENVIRONMENTAL ADVISOR	2	TACTICAL	ENVADV	ENVADV-6
7	MALE	31-35	NOT DISCLOSED	2	TACTICAL	ND	ND-7
8	FEMALE	31-35	SUSTAINABILITY MANAGER	1	STRATEGIC	SUTMGR	SUTMGR-8
9	MALE	41-45	TRANSITION MANAGER	1	STRATEGIC	TRSMGR	TRSMGR-9

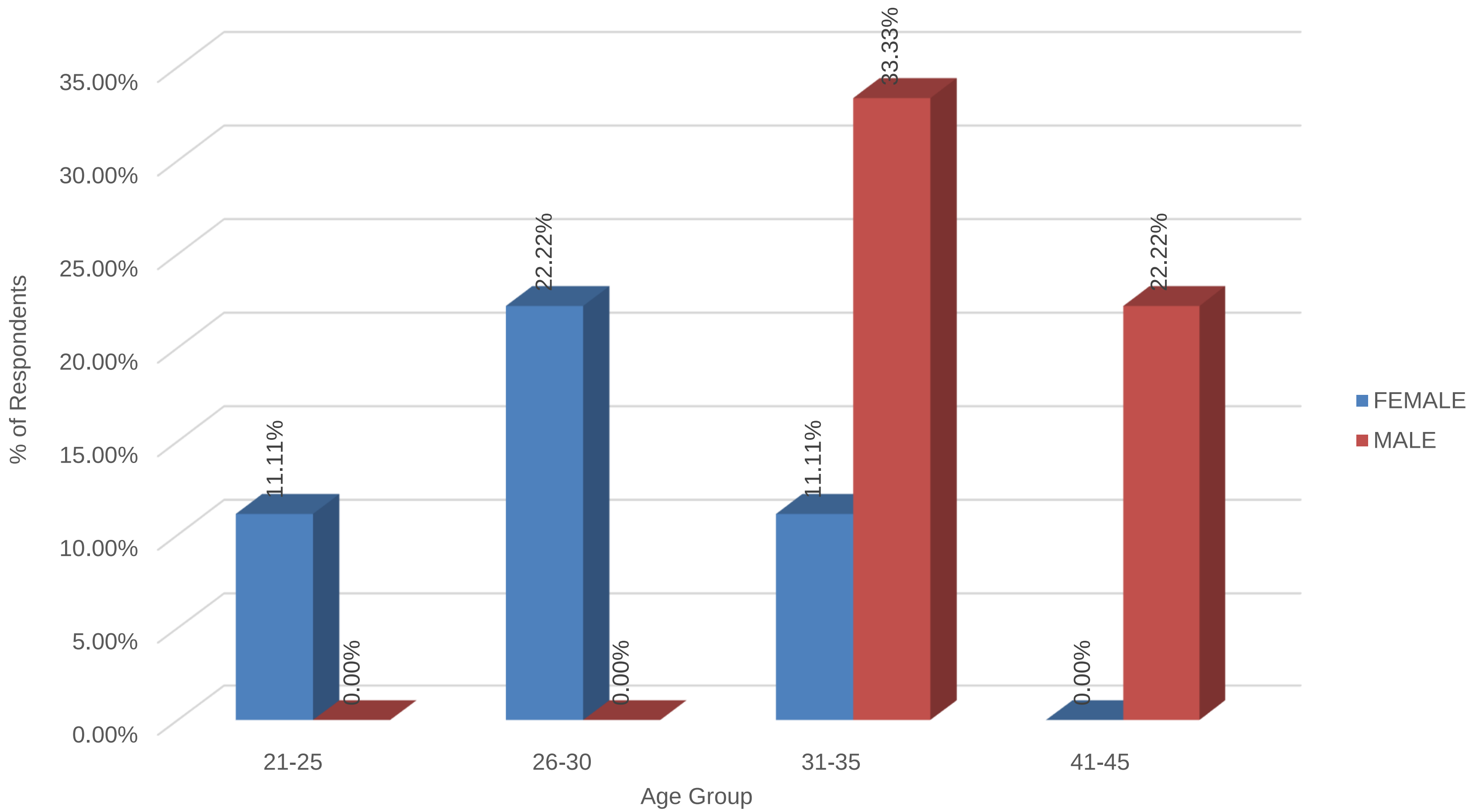


Figure 4:1 Age Group of Participants

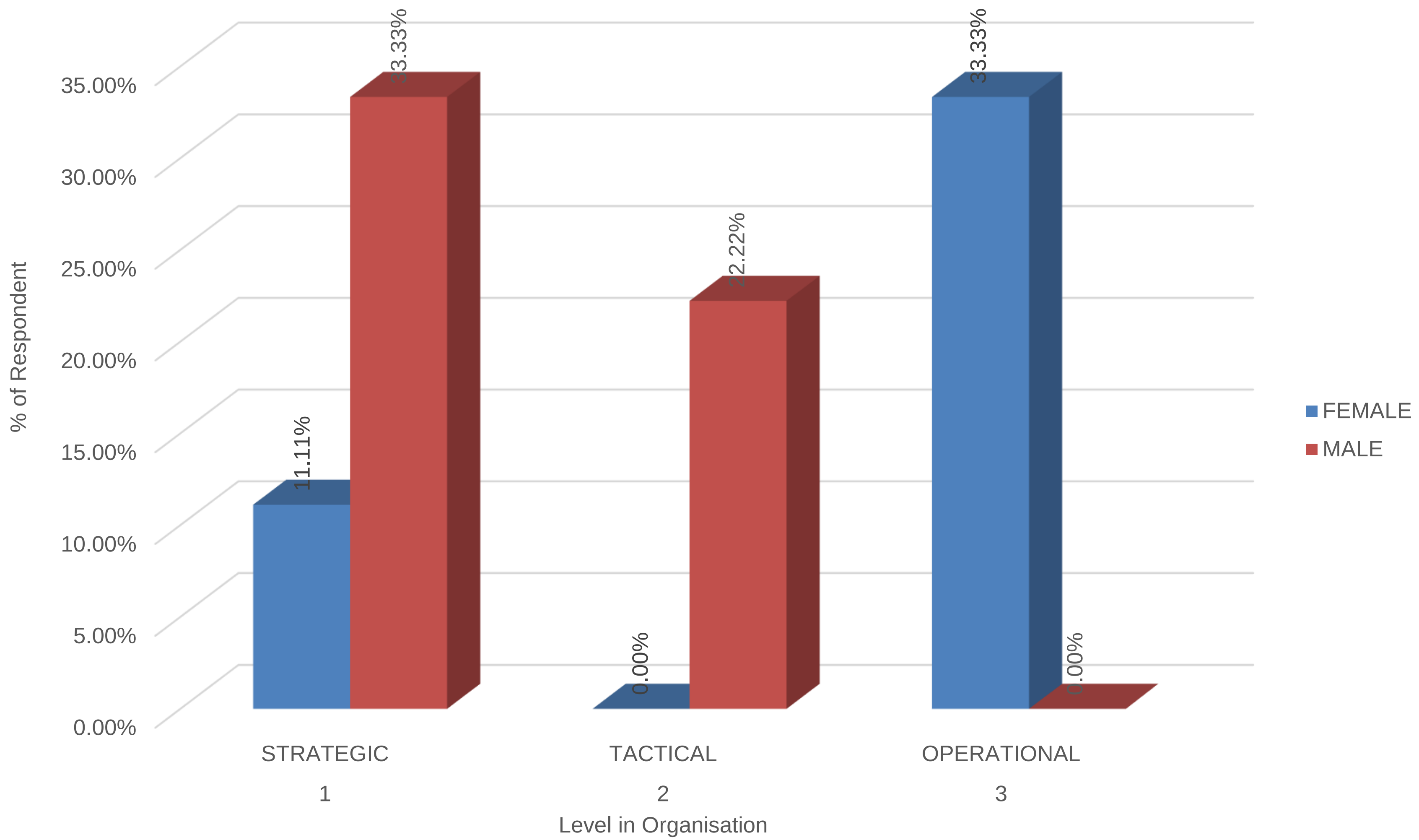


Figure 4:2 Level of Organisation of Participants

4.1 RO1 – Determining the Factors which Influence Asset Information Quality in Facilities Management Operations

An interview pro forma was developed with predefined themes to be discussed after an extended literature review (Appendix I). These were designed as open-ended questions which allowed the participants to express themselves freely without being restricted to set rules or constraints. The interview proforma was used as a guide to direct the discussion however new questions were elicited as new ideas, observation, and comments were made by the participants. The entire interview session lasted between 30 – 60 minutes for each participant.

The data analysis technique utilised for this study was thematic analysis. Thematic analysis has been described as a basic qualitative data analysis approach for analysing and interpreting narrative data (Taylor-powell & Renner, 2003). Taylor-powell and Renner, (2003), also states that narrative data may be derived from several sources which include, but not limited to, individual interviews within thematic analysis technique. These can produce data in the form of notes, a summary of the individual's interview, or word-for-word transcripts (Taylor-powell & Renner, 2003). In addition to the thematic analysis, a frequency distribution of the identified themes was produced to determine the relative occurrence of specific themes as espoused by the respondent. This approach to thematic data analysis adopting frequency statistic have been adopted in information systems research (Remenyi, 1992).

The factors influencing asset information quality in FM have been categorised in a thematic framework using NVivo™ and has been further classified into three domains as follows: (1) information domain, (2) organisational domain, and (3) people domain (see Appendix II). The information domain details factors and influences that bear on information quality of AM programs in FM operations. Similarly, the organisational domain presents factors that influence information quality at the organisational level of AM programs in FM services such as processes and procedures. Finally, the people domain focuses on people factors that impact information quality of AM programs in FM services.

This research utilised the concept as posited by Taylor-powell and Renner, (2003), during the data analysis process and was adapted in the form of a mind-map (Figure 4:3) where the aim here was to visually connect the themes and the categories in order to identify recurring concepts (Budd, 2004; Farrand, Hussain, & Hennessy, 2002). As described by Sure et al., (2002), a mind map is a graph of named nodes which may be linked with further descriptive text. It is based on organising information via hierarchies and categories where the hierarchies and associations flow out from a central image in a free-flowing, yet organised, and coherent manner (Budd, 2004).

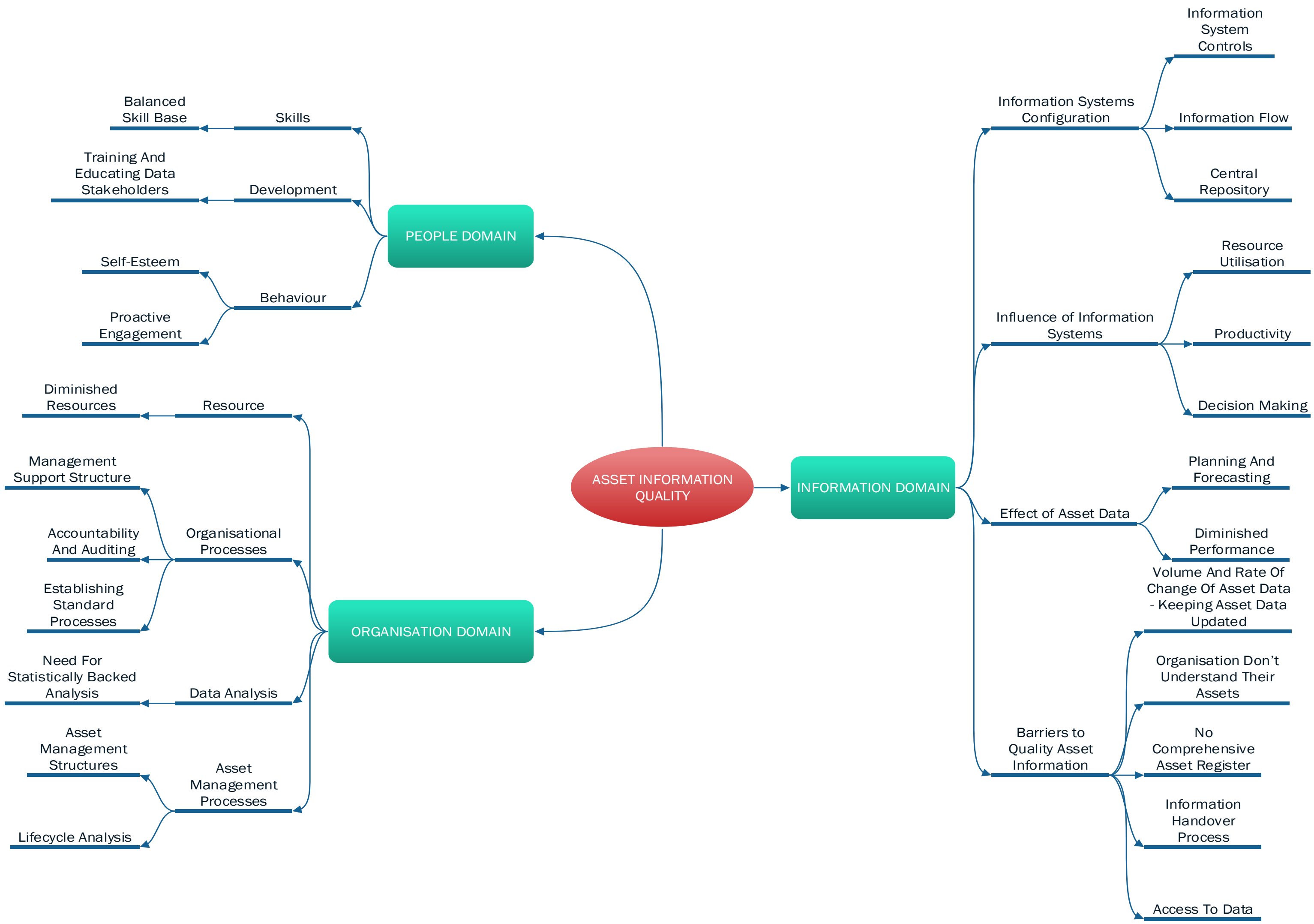


Figure 4:3 Mind Map of Thematic Analysis

Mind maps have been utilised in research focusing on information management, knowledge management, and facilities management (Birks, Fernandez, Levina, & Nasirin, 2013; Farrand et al., 2002; Mingers & Taylor, 1992; Rasmussen, Andersen, & Jensen, 2012). Thus by using mind-maps we can visually outline information with associated ideas, themes, and concepts (Beel & Langer, 2011; Farrand et al., 2002). This approach has been adopted for the interviews. Sections 4.1.1 , 4.1.2 and 4.1.3 presents the finding attributed to the interviews conducted based on the research framework.

4.1.1 Information Domain

Information is an essential element of successful AM (Hanis, Trigunarsyah, & Susilawati, 2011) of which asset data forms the foundation as this aids it effectiveness and translates into improved outcomes for FM operations (S. Lin et al., 2007). According to S. Lin et al., (2007), the effective use of asset data is linked to the revenue generated from AM operations. Though significant quantities of asset data are collected, stored and used for a variety of AM functions and analysis (Koronios et al., 2005), limited value has been obtained from such exercise (S. Lin et al., 2007).

The information domain detailed factors that influenced information quality of AM programs in FM operations. The question asked to determine these factors was: “please explain or describe what factors you consider inhibits or influences asset information in your job” based on the interview pro forma. The analysis of the interview conducted identified several themes that have an influence on asset information quality (Table 4:2 and Figure 4:4) and have been categorised as follows:

1. Barriers to quality asset information
2. Effect of poor information
3. Information system configuration
4. Influence of information systems

Table 4:2 Identified factors influencing asset information quality within the information domain

Theme	Sub-Theme	Sub-Theme Code	No of Respondent	References	% No of Respondent	% References
Barrier to Quality Asset Information	Access To Data	AccToData	5	12	55.56%	10.91%
	Information Handover Process	InfoHandProc	4	6	44.44%	5.45%
	No Comprehensive Asset Register	NoCompAssetReg	5	9	55.56%	8.18%
	Organisation Don't Understand Their Assets	OrgDntUndstdAsset	2	8	22.22%	7.27%
	Volume And Rate Of Change Of Asset Data - Keeping Asset Data Updated	VolRateofChngAssetData	3	3	33.33%	2.73%
Effect of Poor Asset Information Quality	Diminished Performance	DimPerf	4	7	44.44%	6.36%
	Planning And Forecasting	PlnForecastn	3	9	33.33%	8.18%
Information Systems Configuration	Central Repository	CentRep	5	8	55.56%	7.27%
	Information Flow	InfoFlow	4	8	44.44%	7.27%
	Information System Controls	InfoSysCntrls	3	15	33.33%	13.64%
Influence of Information Systems	Decision Making	DescMkng	4	10	44.44%	9.09%
	Productivity	Prodtvty	6	9	66.67%	8.18%
	Resource Utilisation	ResUtil	3	6	33.33%	5.45%
						100.00%
Sample Size (N)		9				
Total References		110				

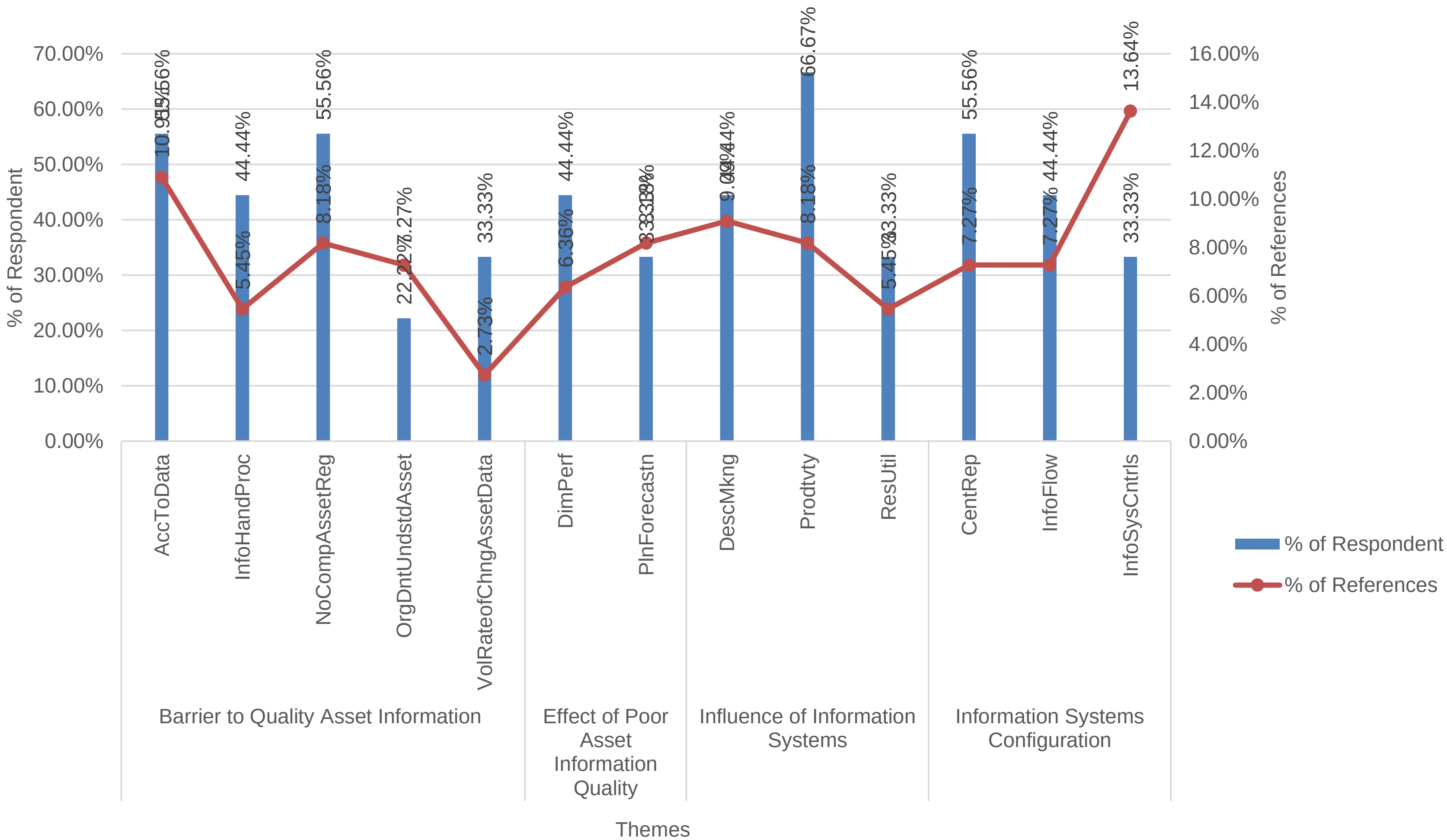


Figure 4:4 Information domain thematic analysis showing the percentage of references against percentage of respondent per theme

4.1.1.A Barriers to Quality Asset Information

The analysis of the interview revealed several factors which inhibits the efficient use of information within AM operations. Within this context, several contributory factors were identified to induce or constitute a barrier to asset information quality. These factors diminish the value information could have on AM programs. The following sub-themes related to barriers were identified:

1. Access to data
2. Information handover process
3. No comprehensive asset registers
4. Organisations do not understand their assets
5. Volume and rate of change of asset data - keeping asset data updated

A.1 Access to Data

This section explores the sub-theme access to data within the context of barriers to asset information main theme. 10.91% of the references in relation to barriers to asset information main theme were coded for access to data. This was accounted for by 55.56% of the respondent in the interview.

Formal information management starts with the definition of data quality goals and a data collection strategy (Weidema & Wesnæs, 1996). According to Weidema & Wesnæs, (1996), during data collection, the quality of data is documented for each set of data. However, it was observed from the interview with OPSMGR-1 that the collection of data was not given enough priority leading to data quality problems. OPSMGR-1 expressed this opinion in the following statement:

> *"…Is the transition appropriate, asset data collection is not high enough on the agenda, it should be number one…It is not collected in a kind of interrogatory details it should be…[as a result]…you try and build up asset information. You undergo asset data review, where you can. That is something that doesn't happen…" (OPSMGR-1)*

S. Lin et al., (2007) corroborates this view by highlighting that fragmentation and inconsistencies among services associated with data collection impede data quality and preclude the ability to ensure data quality is of a high standard. Such fragmentation and inconsistency may result if a data entry point is isolated from the asset or a time lag exists between data creation and data utilisation, whereby the capability for accurately confirming the data is considerably reduced (Koronios et al., 2005). This problem of data access and collection have been highlighted by ND-7 as follows:

> *"…For on the ground operational perspective, the person that is doing the job has very little interactions with the electronic systems. But mainly because of the incentive to get the job done and also the incentive is, well they don't need to have access to the computer…a lot of our system are currently locked behind, they need to be on the centralised intranet and…my people on static sites, have very little access or some don't even have the email address so actually getting it communicated down to engineer level is tricky…" (ND-7)*

This goes to note that improvement in data quality can be achieved through appropriate access and proximity of the asset and data entry point and ensuring data collection hold a prime position within AM programs.

A.2 Information Handover Process

This section explores the sub-theme Information Handover Process within the context of barriers to asset information. 5.45% of the references in relation to barriers to asset information were coded for Information Handover Process. This was accounted for by 44.44% of the respondent in the interview.

Information is regarded as a valuable material in AM. It informs the execution, operations, and compliance activities needed to run a facility optimally (Kristine K. Fallon & Palmer, 2006). Conversely, research has observed that information usability is often low specifically at building handover and commencement of FM operations (Dibley, 2011). Fallon & Palmer, (2006) attributed this to the exchange of information during the handover stage to operations of the building life cycle. It has been further observed that data handover is difficult as key people leave before project completion and different data formats and structures are used in project delivery and operations (Whyte, Lindkvist, & Ibrahim, 2012).

Chanter & Swallow, (2007) bemoaned the way in which handover is performed by indicating that it is exceedingly unprofessional, not only in terms of administrative and practical considerations but also in relation to the information provided to the occupier/owner on the asset. OPSMGR-1 corroborates this argument in the following statement:

> *"…The transition… is not high enough on the agenda…" (OPSMGR-1)*

This issue was further highlighted in the interview in the form of inter-organisational cooperation in the field of FM. In this context FM contract inherited from previous suppliers were hampered due to information handover. According to respondent OPSMGR-1 there is a lack of support from firms that have lost a contract to hand over information:

> *"…If you take over from a previous supplier, they often will not play ball at all by giving you the asset data. Because they collected it so why do they have to give it to you. We did all the work. They just lost the contract so they are not likely to play fair and even if they did they certainly do it [at a] very slow rate, and it ends up with you not going to get the asset data information you want. You use plain information which makes life very difficult…" (OPSMGR-1)*

The consequence from this is the significant cost incurred by the organisation. According to Fallon & Palmer, (2006) the significant cost is incurred in the process of finding and verifying the information provided.

It should be noted that the effectiveness of the handover and commissioning phase is a key determinant of the subsequent performance of the building (Chanter & Swallow, 2007). Chanter & Swallow, (2007) argued that improvements are only likely to come about when there is an increased awareness of this link by building owners, which will prompt a demand for better service. Whyte et al., (2012) proposed the development of handover processes, checklists to ensure completeness of information at handover.

A.3 No Comprehensive Asset Registers

This section explores the sub-theme No Comprehensive Asset Registers within the context of Barriers to asset information. 8.18% of the references in relation to Barriers to asset information were coded for No Comprehensive Asset Registers. This was accounted for by 55.56% of the respondent in the interview.

It is important that physical assets comprising the facility be described and supported by documentary evidence to assist in identifying them uniquely, as well as providing essential information to inform the facilities management process (BSI, 2012). Achieving this requires the use of asset registers. Different viewpoints have been associated with asset registers. BSI, (2012) defines asset register as the collection of records holding information about facility assets in terms of their manufacturer, vendor, make model, specifications, date of acquisition, initial cost, maintenance cost and requirements, and accumulated depreciation. M.A. Hassanain, Froese, & Vanier, (2003) defines asset register to include asset name, identifier, location, expected life, original value, current value, depreciated value, total replacement value, incorporation date, commissioning date, and warranty duration from the manufacturer. Jones & White, (2012) provides a simpler definition of asset register as a list of all property assets owned or leased by an organisation together with background information on each asset. Irrespective of the definition adopted, these classifications of asset registers are congruent and possess characteristics that ensure its effectual use.

Asset registers are the main data source about buildings used in operations (Whyte et al., 2012). They are viewed as a comprehensive source of information for AM (French, 1994). Asset registers are represented as a list of assets in an AM system, which includes associated manufacturing data, performance characteristics, locations, and maintenance histories used during the operation phase (Whyte et al., 2012). They house information relating to various aspects of an asset portfolio, allowing it to be cross-referenced and retrieved as needed (K. Brown et al., 2014). In accounting terms, the asset register contain information about the assets for the purpose of capital accounting which involves the calculation of the appreciation and depreciation of assets (French, 1994; Jones & White, 2012; Woodward, 1997). As such asset registers must be prepared to a level of detail to meet the specific requirements of the building (R. H. Rooley, 1993).

AM programmes are best controlled using tools which link the asset register for each facility (RICS, 2013). This ensures an efficient use of time by operatives and the completion of records enabling the performance of the facility to be tracked (Mohammad A. Hassanain, Froese, & Vanier, 2003; RICS, 2013). However, evidence illustrates that asset registers vary and are not always in a user-friendly form for non-specialist (NHS Estates, 2003). This view has been expressed by PLNR-2 as follows:

> *"…They think the people on the other side of the phone have a full asset list they know exactly what it is. They say I have got a light out in room m6; they assume that the person on the other end will be able to press the button and it will tell them what light they need to put in that particular place and everything will be sorted…no, we don't have any asset list. The nearest we got is the planned maintenance stuff and even that it is not put together properly yet…" (PLNR-2)*

An addendum to this evidence demonstrates that as no standard format for asset registers exist (French, 1994), non-specialist staff require assistance in interpreting and focusing on the information needed within the asset register (NHS Estates, 2003). This result in the limited or inappropriate use of asset registers thus making it challenging for decision makers to review the critical performance of assets, thereby limiting their ability to achieve, successfully, adequate returns (Hanis et al., 2011). This view has been surmised in the comment made by PLNR-3 as follows:

> *"…to be honest as a facilities management company, we should be aware of what asset that we are looking after. We should be aware of what [break] in an ideal world, we know we would have an asset list of every single asset within each room or each building. So if someone phones in a job and say we have a problem with our fluorescent tube in room "A", we could bring up a list and say you don't have any fluorescent tube in room "A" according to our list. That makes sense so we know exactly what we are looking for…" (PLNR-3)*

Based on the evidence provided above, the effective utilisation of asset information depends on the data quality attributes, comprehensiveness, completeness, and usability, of the data contained within the system. These are achieved through structured configuration of the data through the asset register. However, the statements made by respondents PLNR-2 and PLNR-3 suggest that the lack of an asset register not only diminishes their ability to tackle queries effectively but also reduces the quality of information at their disposal.

A.4 Organisation Don't Understand Their Assets

This section explores the sub-theme Organisation Don't Understand Their Assets within the context of Barriers to asset information. 7.27% of the references in relation to barriers to asset information were coded for Organisation Don't Understand Their Assets. This was accounted for by 22.22% of the respondent in the interview.

For effective utilisation of asset, it is required that managers have a detailed understanding of the assets under management (French, 1994; RICS, 2013). Understanding what information is needed to support decision-making process and what data can be gathered is an essential starting point (Ouertani, Parlikad, & McFarlane, 2008). Asset information is very important for organisations because it represents the collective knowledge used to manage assets as well as to produce and deliver products and services to customers (Ouertani et al., 2008). AM plays a key role in the detection and evaluation of decisions leading to long-term economic success (Schneider et al., 2006). However, this is often not the case (French, 1994). French, (1994) indicated that for some organisations, the extent of asset ownership awareness is limited. However, this can be mitigated by the introduction of external organisation specialising in AM through outsourcing (Houston & Youngs, 1996). This view has been expressed by OPSMGR-1 in the statement:

> *"…Also, a lot of organisations don't understand their assets. Good FM companies can allow organisations to understand their buildings better, to understand the assets they have within those buildings and in some cases can change the maintenance regime to save money. It is about working in partnership with the organisation or in this case the client…" (OPSMGR-1)*

The ability to harness the full potential of an asset depends on the data held by such organisation. Mecanique et al., (2011) posits that knowledge of asset data is important in assessing the performance of the asset. The efficient use of asset data leads to reliable detection and anticipation of performance deviations (Mecanique et al., 2011). However, evidence from the analysis suggest that there is a lack of awareness of the use of asset data by organisation operating in the AM sphere:

> *"…Often the FM companies own more information than the organisation themselves…Organisations don't tend to have the best asset data about what asset they have. The first part of any contract is*

to collect that asset information. I have not seen perfect asset data yet. I think it is an area of improvement…" (BDMGR-5)

This statement thus endorses the need for an organisation to engage efficient asset data management strategies. According to Mecanique et al., (2011) asset data management enables the retrieval of reliable information to enhance decision-making. It enables identification of failures, diagnostic, and prognostic issues in AM (Mecanique et al., 2011) thereby enabling the enterprises to achieve greater returns on their asset (Laney, 2001). Asset information management must further comprise data acquisition, data cleansing, data analysis and data visualisation to achieve full potential (Mecanique et al., 2011).

A.5 Volume and Rate of Change of Asset Data - Keeping Asset Data Updated

The quantity of information generated by AM operations has been recorded in different studies to constitute a challenge for practitioners (Chanter & Swallow, 2007; Jajac, Knezic, & Marovic, 2009). In the workplace, information is seen as the key to success for the organisation (Edmunds & Morris, 2000).

This section thus explores the sub-theme Volume and Rate of Change of Asset Data - Keeping Asset Data Updated within the context of Barriers to asset information. 2.73% of the references in relation to barriers to asset information were coded for Volume and Rate of Change of Asset Data - Keeping Asset Data Updated. This was accounted for by 33.33% of the respondent in the interview.

According to Chanter & Swallow, (2007) large quantity of information is generated by asset operations and its management can be complex. This can be triggered by the rate of change in information technology systems, and as enterprise see information as tangible assets (Edmunds & Morris, 2000; Laney, 2001). However, as the volume of information increases the relative value decreases proportionately (Laney, 2001). These views have been evidenced from interviews conducted and highlighted by participants within this research. For instance, according to PLNR-2 keeping asset data updated is a huge task that limits the potential for asset data:

> *"…And even working for companies where you do have full asset list, the database that you have to hold it [in] would just be tremendous. I mean we spent ages trying to put the asset into tabs FM once, and it still did not work because asset change, and it is such a massive task to keep it updated. It was still quite difficult even though you knew that one point your asset list was [in audible] then it only takes a few weeks, and it is changed again. And it is such a massive thing to keep updated.…" (PLNR-2)*

While (PLNR-3) acknowledge the autonomy of clients in the change of asset:

> *"…To an extent we do when it comes to preventive maintenance but for reactive not really, because the client can bring new assets if they want to…" (PLNR-3)*

From this evidence, it is observed that asset data held in a database presents a challenge to operators when keeping it up to date due the volume and rate of change introduced by clients and other parties. This phenomenon may manifest in its self in various negative forms. For instance, as many people deal with an overwhelming amount of information from many sources as part of their job (Edmunds & Morris, 2000) it leads to a deficiency in information availability (Chanter & Swallow, 2007). This often results in stress, loss of job satisfaction, and physical ill health (Edmunds & Morris, 2000). Edmunds & Morris, (2000) further argued that the abundance of information threatens to diminish operators control over a situation thereby affecting the performance of the activity being carried out.

4.1.1.B Effect of Poor Asset Information Quality

This detailed the effect of the ineffective use of asset information on FM operations. Two (2) themes were identified within. These were:

1. Diminished performance
2. Planning and forecasting

B.1 Diminished Performance

This section explores the sub-theme diminished performance within the context of effect of poor asset information quality. 6.36 % of the references in relation to effect of poor asset information quality were coded for diminished performance. This was accounted for by 44.44% of the respondent in the interview.

Spires, (1996) noted that competitive advantage could be obtained from the effective use of asset through cost and efficiency savings. The effective use of assets in this context is achieved through the philosophy of AM which is the art of balancing cost, performance, and risk (R. E. Brown & Spare, 2004). As such there is an amplified focus on organisations to improve performance which entails in-depth analysis of business processes and investments in assets (Spires, 1996).

Performance has been defined as the expected reliability of the behaviour of a product related to use (R. E. Brown & Spare, 2004; Mohammad A. Hassanain et al., 2003). Thus, when the asset is out of use, they represent a significant cost through lost production, output, and customer credibility (Spires, 1996). In order to avert this situation, there is a requirement of highly trained staff who are able to handle the sophistication of asset technology and the impact of downtime (Pintelon & Gelders, 1992). They will need more diagnostic skills to cope with complex assets (Pintelon & Gelders, 1992). Pintelon & Gelders, (1992) emphasised that success in this area depends highly on the information systems, which provide both technical and historical data of assets.

To this end, research has advocated the adoption of methods for effective data collection to ensure that performance of assets is guaranteed (Kirkham, Alisa, Silva, Grindley, & Brondsted, 2004). Conversely, Kirkham et al., (2004) acknowledge that handling data can become a challenge where complexities exist leading to performance deterioration.

Based on the findings from the interview, it was observed that data constituted an impact on the performance of asset programs in FM operations. For instance, the respondent OPSMGR-1 in the following statements echoes this view:

> *"…So your input of asset data, if it is crap then it is not going to allow you to be efficient in your process…(OPSMGR-1)*

> *"… [The result are] wasted visits, or inability to strategically influence the organisation you are working with. If you don't have that information you are using some kind of plan information, it will take you a long time to build it up if you ever get the opportunity to build it up. So you are not really giving the added value you think you are going to give to that organisation…" (OPSMGR-1)*

While BDMGR-5 states:

> *"…An example would be [you think] if I send an engineer to fix a piece of equipment and when you get there the piece of equipment is not the same that you think it is so the engineer has not got the skill for that before the visit. So he goes there thinking he is going to fix item A and he has got the skills for that, [and] when he goes there it is item B and he hasn't got the skills…" (BDMGR-5)*

This finding reflects the view of Kirkham et al., (2004). Research shows that inappropriate or unusable data contributes to high levels of dissatisfaction amongst building owners (Jones & Sharp, 2007) which comes as a result in performance losses due the unusable data. OPSMGR-1 attributed this issue to the generic nature of data used during AM operations:

> *"…In a lot of cases that is a generic makeup of asset information rather than on-site inspection of all assets. If the information in the system is generic, the response is going to look pretty generic…" (OPSMGR-1)*

OPSMGR-1 went further to note that AM operations may achieve the outcomes that might have been set with asset data:

> *"…It [Asset Data] makes everyone's jobs easier, as a service coordinator to understand the information about that asset, it is going to make your job a little bit easier, it is going to make the engineers job easier, the contract managers job easier, everybody benefits from good asset data…" (OPSMGR-1)*

The final statement made by OPSMGR-1 has been encapsulated in real-world events by PLNR-2 as follows:

> *"…They just think the light is out; they think the people on the other side of the phone have a full asset list they know exactly what it is. They say I have got a light out in room m6; they assume that the person on the other end will be able to press the button and it will tell them what light they need to put in that particular place and everything will be sorted.…" (PLNR-2)*

This statement bears a tone of frustration exhibited by PLNR-2 that attest to the statement made by OPSMGR-1 about the ease with which AM operations may be carried out with adequate asset data.

B.2 Planning and Forecasting

Planning and forecasting is a core management function that enables the successful running of organisations. These concepts have been used extensively in fields such as supply chain management (SCM) (Stadtler, 2005), private finance initiative (PFI) (Boussabaine, 2007), building maintenance (Lind & Muyingo, 2012), performance management (Neely, Gregory, & Platts, 1995), and financial investment (R. E. Brown & Spare, 2004). According to Stadtler, (2005) planning aids in supporting the material flow across a supply chain and related business functions. It must consider all activities that impact performance and risk (R. E. Brown & Spare, 2004).

R. E. Brown & Spare, (2004) insists that forecasting and planning remain a vital aspect of AM which requires a great deal of data both for the assessment of probabilities and assessment of consequences (Khan & Haddara, 2003). The tasks of planning can be considered at different levels of aggregation and intervals ranging from aggregated long-term to detailed short-term planning (Stadtler, 2005). Based on these assertion, R. E. Brown & Spare, (2004) surmised the goals of AM to balance cost, performance, and risk; align corporate objectives with spending decisions, and create a multi-year asset plan. These goals are premised along rigorous data-driven processes based on asset-level data derived from business processes (R. E. Brown & Spare, 2004; Pant & Ravichandran, 2001).

To this end, evidence from the interviews indicated that planning and forecasting is a major concern within the context of effect of poor asset information quality in AM program. 8.18% of the references in relation to effect of poor asset information quality were coded for planning and forecasting. This was accounted for by 33.33% of the respondent in the interview. The respondents emphasised that planning and forecasting relies on the availability of data which guarantees that success is achieved. Within this, the theme cost, planning, and forecasting were determined to be dependent on good asset data. Good asset data was perceived as an enabler to improve the outcomes of AM. For instance, OPSMGR-1 stated implied in the comment:

> *"…I think that is good facilities management and by that, I mean good AM and good asset data then enables you to really plan and forecast your cost, and that would be around replacement of items, understanding how many times a particular asset is being repaired, the detail of what is being repaired within that item. [It] Should be able to allow you to forecast when you might need to replace it and obviously the cost that is involved in that. Knowing what is around the corner financially enables any business or any organisation to plan its business accurately and well.…" (OPSMGR-1)*

OPSMGR-1 further noted that a strategic position of influence could be attained to enable planning and forecasting at the strategic level by understanding the data and information:

> *"…You have to understand the facilities that you are talking about and the assets you are talking about. It is about that data or that information understanding that information, analysing it and seeing where you can influence strategic forecast or planning of an organisation…it is hard to make bold statements of what you can do for an organisation without it being time dependent savings, sustainability, we can make you greener. All of those things we can do over a period of time or after a period of time but the first bit is let us understand what the asset within that FM contract is all about e.g. age, profile, condition, volume, actual asset information…" (OPSMGR-1)*

By understanding the asset data perspective to planning, organisations are enabled to determine many other aspects that can be improved as described by PLNR-3:

> *"…Identifying the problem before you get there. That is raw asset data in the first place and then the day-to-day process, engineer whereabouts, engineer expected attendance time, how long he thinks that jobs are going to take. In terms of other information that can be supported by the system detailed asset data and so what about the asset itself and then historical asset data. How many times it's been repaired. What repairs has been done, how much has it cost, etc..." (PLNR-3)*

4.1.1.C Information Systems Configuration

Information system configuration was identified as a main feature influencing AM information. This was investigated to determine what factors within this influenced the quality of asset information within AM programs. These factors were identified within NVivo™ and subsequently developed into sub-themes which included:

1. Central Repository
2. Information Flow
3. Information System Controls

C.1 Central Repository

This section explores the sub-theme central repository within the context of factors influencing information quality. 7.27% of the references in relation to factors influencing information quality were coded for central repository. This was accounted for by 55.56% of the respondent in the interview.

AM systems have been described as an integrator that can interact with and interpret the output coming from many dissimilar systems (Halfawy, Newton, & Vanier, 2006). Part of this system is composed of a central repository consisting of a relational database and a set of add-on modules (Halfawy et al., 2006). This is an important factor to assure the quality of information for AM. The AM system forms a component of the information management structure that enables adequate flow of information within organisation hierarchy. It provides a single point of contact for analysts and users to look up definitions of data elements, reports, and business views; trace the lineage of data elements from source to targets; identify data owners and custodians; and examine data quality reports (Eckerson, 2002; Hayes, 2008). This view was mirrored by ENVADV-6 in the comment:

> *"…Within [the organisation] we have what we call an integrated management system. It has all the paperwork we need in order to do our jobs properly. It has been completely audited, and the system is fine so if we follow what that system says then we can be confident that we are doing everything exactly the way we should…" (ENVADV-6)*

However, despite this advantage, Shen, Hao, & Xue, (2012) reported that in the construction industry, the use of a single central repository to store the information is not usually a viable option due to the fragmented nature and adversarial behaviour that characterises the industry. Further to this VANIER, (2000) indicated that the lack of central repository for the information has been identified as a challenge to fully address the need for asset planning. To this end, ND-7 indicated that information is rather chaotic and lack coherence for use, which supports the argument posited by VANIER, (2000). This has been encapsulated in the following statements by ND-7 as follows:

> *"…We have got to look at a 20 year or 30 year contract to maintain it so there is a huge variety of information especially. There is an aim to bring online a kind of BIM building information management or something like that…currently the information received is a lot chaotic, not necessarily streamlined in the way that we want it to be…" (nd-7)*

> *"…lots of stuff going on lots of phone calls occurring. It is impossible to actually try to get somebody to, a single point of contact, to bring all that together, and ultimately that role, electronically database based, so to actually create order to the chaos you have a CAFM system, which logs all the jobs and then will stage it as it occurs. Everybody has access to it, so if you have an update they literally put it in that, it is not a perfect as that and you…" (ND-7)*

This view confirms the evidence posited in research studies on the limited use of central repositories in the industry. Research have identified the limited or miss use of central repositories as a means of storing information that can be accessed by all parties involved in a project (W. Hughes, Sun, Oza, & Wilkin, 2007). For instance, ND-7 indicated that there was very little access to the information systems:

> *"…A lot of our systems are currently locked behind, they need to be on the centralised intranet and because of all of us, and even my people on static sites, have very little access or some…" (ND-7)*

To this end, several authors have proposed the use of central repositories as a central spine for information management (Alexander, 2008; Michail Kagioglou, Cooper, Aouad, & Sexton, 2000) with the aim to enhance the quality of communication, the information flow and services provided by organisations (Luna-Reyes, Zhang, Ramón

Gil-García, & Cresswell, 2005). However, it was observed that this was lacking based on the evidence provided by the respondent BDMGR-5. According to BDMGR-5, no common system led to information quality problems such as keeping the data up-to-date:

> *"…I think that there is no common system that talks to each other so e.g. a constructor will assemble the asset might use BIM but use it to manage the program of construction and overtime as installed asset change the system might not be updated so the people on the ground might not know that they have installed a different item of plant. Even if asset information were to be transferred electronically, if it has not been kept up to date by the constructor you still going to get gaps. We don't have a common database that you use for construction and installation and then subsequently maintenance…" (BDMGR-5)*

While TRSMGR-9 indicated:

> *"…Yes, there is certainly no consistency in terms of the collation of data and there is no central repository to put anything. That is one of the other issues we have here; document control is appalling. Everyone uses a pen drive as opposed to a central point of collation. So that means that data will be stored in different formats and in different places so there is no centre for the information to go back to for anyone to do any type of analysis on it. So nothing is ever joined up…" (TRSMGR-9)*

Uniquely, the use of spreadsheet was prevalent in the application of data management. This emanated from the void created by the lack of a central repository for decision-making. This further presented problems to quality data. For instance, SUTMGR-8 noted that spreadsheets were used as a basis for reporting, due to a lack of a common data management system, which often resulted in complexities and errors:

"…One thing has come to me as awful is the use of the spreadsheet as a basis of reporting. Apart from the CAFM system, I would say there is no common data platform apart outside of the spreadsheet. Everybody has a spreadsheet or something…there is no common data management system so the spreadsheet will be used for say the energy management is generally a spreadsheet management process…that seems to be the real problem for this company. It is the spreadsheet. And once you start making excel spreadsheet complex you often find errors throughout the calculations…" (SUTMGR-8)

The spreadsheet has been the dominant tool for managers to perform analytical procedures or decision-making (Kruck, 1998). The uses of spreadsheets in organisations have been encouraged by its relative ease of use and the ubiquity of the application (Baskarada, 2011). However, this is its Achilles heel, and despite its advantages, possess peculiar drawbacks that limit its ability to handle information effectively. For instance, spreadsheets are prone to user-imputed error thus corrupting the information held within it (Ballou, Pazer, Belardo, & Klein, 1987). Also, spreadsheet is relatively unable to handle large and very complex data set (Kruck, 1998; Redman, 1998).

C.2 Information System Controls

This section explores the sub-theme information system controls within the context of factors influencing information quality. 13.64% of the references in relation to factors influencing information quality were coded for information system controls. This was accounted for by 33.33% of the respondent in the interview.

The need for having more control was observed as a factor that influences the quality of information within the system. 15 references were made to the factor which indicated its relevance for the respondent. However, this section captures a snapshot of these factors. Specific to this was the need for mandatory fields that hold data in a specific structure. According to respondent OPSMGR-1 the issue with mandatory information was highlighted as follows:

> *"…From a control point of view is how you set up mandatory information fields. Mandatory information and how that information is logged…controls on those mechanisms are not as strong as we would like…" (OPSMGR-1)*

Having such control within the system takes the form or referential integrity which ensures relevance, accuracy, and completeness of the information (Dibley, 2011). This ultimately lessens the redundancy and inaccuracies associated with duplication of information (Abudayyeh, Khan, Yehia, & Randolph, 2005).

However, it was noted that the problem of information control might be prevalent within the industry. For instance, ENVADV-6 commented on this as follows:

> *"…Think does have a problem, and I don't know if this is across the whole of the FM industry with information governance (wrong word), [I mean] with document control. If you go into the public drive on any of the sites there…" (ENVADV-6)*

This view was further acknowledged by TRSMGR-9 indicating the extensive use of portable storage devices (PSD) such as pen drives to hold information thus compromising the effective control of information. This view was encapsulated by the comment made by (TRSMGR-9) as follows:

> *"…One of the other issues we have here, document control is appalling. Everyone uses a pen drive as opposed to a central point of collation. So that means that data will be stored in different formats and in different places so there is no centre for the information to go back to for anyone to…" (TRSMGR-9)*

As reported by TRSMGR-9, the use of PSD presents a significant problem to information quality as such information held within the device may take various forms which may not be compatible with the intended use.

In addition to this, further issues relating to the PSD have been reported in research. For instance, the malicious introduction of unwanted information to corrupt the targeted system and the legal implication associated with information held within this device (Gorge, 2005; Watson, 2006). To avert such issues from occurring, Watson, (2006) posited technical solutions for securing PSDs at device level which include encryption and password protection to prevent unauthorised access the data. Such solutions were reported by ENVADV-6 who indicated its use in projects outside the field of FM as follows:

> *"…There are some projects that I know that is outside of the FM section of [the organisation] that do this very well. So I have been told that the project that we have [with our client] have a little bit of completely control password protected document control system so you cannot alter the entire document directly, you have to get permission…" (ENVADV-6)*

This further corroborates the lack of control presented by TRSMGR-9 and OPSMGR-1.

The lack of enabling certain areas mandatory further exacerbates the challenge of enforcing control within operation as highlighted by OPSMGR-1:

> *"…We have [some] control here but they are not always mandatory. The controls are me knowing what I would put into that job to allow the engineer to complete it…we like to control what that description is through the drop down menus or standard description rather that free text [as such] there is too much freedom to influence the information as the controls are less structure than we wold like…" (OPSMGR-1)*

It may be assumed that the level of control applied within the systems influences the way information is used. This thus affects AM programs in FM operations as the lack of mandatory fields allows users enter free text, which may lead to erroneous data recorded. Thus, having strong controls for the way data is handled is desired as noted by OPSMGR-1:

> *"…Having a system that you can make certain areas mandatory, you could make certain areas drop-down fields you can structure the system to say I want an additional piece of information for these types of jobs for this contract. We have contracts that want that additional piece of information…" (OPSMGR-1)*

C.3 Information Flow

This section explores the sub-theme information flow within the context of factors influencing information quality. 7.27% of the references in relation to factors influencing information quality were coded for information flow. This was accounted for by 44.44% of the respondent in the interview.

Information flow and capture emerged as a theme that influences that utilisation of asset data. Eight (8) references from three respondent made an important contribution as to how this factor influences AM programs in FM operations. The flow of information has a profound impact on its quality and the delivery of a project. As noted by Titus & Bröchner, (2005), the quality of information received, the timeliness of the manner it is received, and the cost-effectiveness in obtaining the information determine the efficiency of an operation. These are enabled by the adoption of enterprise systems which have improved the organisational information flow (Al-Mashari, Al-Mudimigh, & Zairi, 2003). The benefits of a seamless flow of information within an enterprise have been recorded in various studies. Significantly, this encourages sharing of information between disparate parties in an operating environment. For instance, OPSMGR-1 noted as follows the means of sharing information:

"…We have gone beyond me being able to report it and the person here on the helpdesk being able to ask enough question to get a detailed response. We have gone one step further to can the person reporting it give enough information to the system directly may be a tablet or through a hand-held device that gives enough information to the engineer that enables him to come out better prepared…" (OPSMGR-1)

This statement supports the view held by Titus & Bröchner, (2005) with regards to performance. According to Titus & Bröchner, (2005) sharing information is a key component for tight integration of teams to optimise performance and produce high-quality service. Information sharing is an aspect of information flow which implies two-way communications (Durugbo, Tiwari, & R. Alcock, 2014). This approach leads to better means of managing the information flow resulting in enhanced productivity of projects (Titus & Bröchner, 2005).

Though the sharing of information presents significant benefits to information flow, there are inherent challenges associated with its application such as information leakage, which occurs when information ends up in the hands of unintended recipients (Durugbo et al., 2014), and waste (Hicks, 2007; Jylhä & Suvanto, 2015).

Information flow is needed to overcome problems associated with fragmented supply chains (Durugbo et al., 2014). According to Durugbo et al., (2014) information flow incorporates information access, information exchange and documentation. Information flow is undertaken to add value to the operations performed by organisations (Hicks, 2007). However, inefficiency do exist in handling information which does not depend solely on the industry process, or the technologies adopted (Titus & Bröchner, 2005). This situation further leads to waste of resources (Jylhä & Suvanto, 2015) and according to Hicks, (2007) waste can be considered to be represented by the barriers to improving information flow. This phenomenon was reported by PLNR-2 in the interview. According to PLNR-2:

"…It is poor sharing of information. This has a massive impact as I have explained. If you do not have the knowledge, then you are sending wrong engineers to jobs. You are just wasting time. You are wasting everybody time and put you in a bad light with your client…" (PLNR-2)

It was observed that poor sharing of information resulted in waste and dissatisfaction within AM operations which supports the notion presented by Hicks, (2007). Hicks, (2007) further suggested the use of techniques such as information flow mapping as essential for identifying and understanding all information flow in a bid to reduce waste.

Information flow integration is crucial for quality management and for building and sustaining relationships in arrangements such as partnerships or alliances (Durugbo et al., 2014). One of the critical elements in achieving flow is the development of an integrated information system infrastructure where data exchange occurs automatically and in real-time (Hicks, 2007). According to Chanter & Swallow, (2007) as demand from internal and external sources for more efficient information flow increases, systems automation are fast becoming the dominant force. This view was identified in the study and specified by SUTMGR-8:

"…If there is a sought of reliable automated platform, [that] will be great. For instance, you have to; i think you would always have to do it manual meter readings then if you were to reduce them to say quarterly or six monthly it will just be a check rather than do them every month. That will be a great saving of time…" (SUTMGR-8)

What might be inferred from the comment made by SUTMGR-8 is the prevailing use of manual methods within the information flow process. This goes to show that there is limited automation to information flow which helps improve the quality of information in AM operations as indicated by PLNR-3 in the following comments:

"…It is only as good as the information that gets imputed in by the staff. Because it is you, that put the job in. It is not an automatic software where you can take to a particular site, and it can list everything in there.…" (PLNR-3)

"…Once again… because we get our calls, manually it depends on what information you can give and what the planner can take from the customer as well…" (PLNR-3)

As an addendum, Chanter & Swallow, (2007) posited that a proactive attitude towards information flow leads to higher levels of quality being achieved. However, it was observed that such an attitude was not present within AM operation in the form of processes or procedures that managed the flow of information adequately. This was highlighted by OPSMGR-1 in the following statements:

"…Asset information, [I], don't know of a process of managing that flow of information…" OPSMGR-1

"…Processes of managing that flow of information usually a transition manager will be provided with the asset data. This hit MAXIMO then hits iContact but in a lot of cases this is a generic makeup of asset information…" (OPSMGR-1)

This absence of adequate flow of information resulting in a generic makeup of asset information manifest itself in the impact it has on AM operations. This has been highlighted by PLNR-3 as follows:

"…In the real world we are performing great and the customer is having everything that they needed, however, statically and on paper, it did not look like we are performing because the information was not relayed back to us correctly and it looks like we had not been carrying out any work…" (PLNR-3)

PLNR-2 further acknowledged that the absence of information could cause a reduction in the use of resources:

> *"…This leaves me short of engineers if I am sending someone back to do something that could be done the first time. That takes a man off the next job…" (PLNR-2)*

The inference made from this comments indicate that information flow has a profound impact on the performance of the operations being carried out by personnel. This confirms the argument put forward by DAVIDSON, DAVIDSON, & RUBERG, (1988). According to DAVIDSON et al., (1988) control of information flow is seen to hold the key to improved performance.

4.1.1.D Influence of Information Systems

Under the information system attributes, the focus was the application of information systems to AM operations, and how the information held by such systems influenced the outcome of AM programs. The dominant theme identified and investigated here was applicability. The following sub-themes were identified within NVivo™:

1. Decision Making
2. Productivity
3. Resource Utilisation

D.1 Decision Making

This section explores the sub-theme decision making within the context of influence of information systems. 9.09% of the references in relation to influence of information systems were coded for decision making. This was accounted for by 44.44% of the respondent in the interview.

Decision-making emerged as an important area within AM programs that is influenced by the information systems used. Decision making is a process of choosing among alternative courses of action for the purpose of attaining a goal (Turban, 1993).

According to Chaffey and Wood, (2005), the quality of information is vital to supporting decision making. Chaffey and Wood, (2005), argued that the realm of decision-making theory should underpin the approaches to quality information management. Within the field of facilities management, there is scant evidence, from research, of the application of decision-making concepts. This seems to diminish the importance information has on AM operations. However, evidence from the research indicates that utilisation of the decision-making process is an important factor in AM. For example, a quote by OPSMGR-1 stated:

> *"…Being able to provide a comparison of the information within the system…that is what we are designed to do in terms of providing FM services…" (OPSMGR-1)*

Thus personnel would have to be able to make a comparison from the information provided from within the system to make a crucial decision that affects AM programs. This can be related to information acquisition and use as posited by Frishammar, (2003). Frishammar, (2003), noted that such information acquisition and use precedes strategy formulation and decision-making. However, this is not to imply that decision-making may or should be diminished in importance but the source or origin of decision-making, which is the information, should be carefully constructed. This case was observed from the participants *OPSMGR-1 and PLNR-4* during the interview:

> *"…The first part of any contract is to collect the asset information…it influences strategic forecast or planning of an organisation…" (OPSMGR-1)*

> *"…The more information that we have the easier it is to make a decision and the faster it is to get the work order through the system..." (PLNR-4)*

Decision-making is a vital component of AM programs, which forms part of personnel activities. To aid the process managers adopt the use of decision-making systems (DSS) which rely on complete data and provide objective outcomes based on logical methods (Sauter, 1999). They utilise tools which enable the decision-maker to extract and manipulate database fragments for resolving situations (Sauter, 1999). One such tool described in the interview was the utilisation of decision trees that assist operators in achieving better outcomes. This was identified by OPSMGR-1 who explained as follows:

> *"…There are FM systems of use that can really deliver a decision tree for the person logging the job…the system having a decision tree i.e. drop-downs then to say it is leaking and if it is leaking, it is doing this? Can I switch it on, can I switch it off, may be given first aid advice to the person logging the job. What you need to do right now is make sure that asset is switched off and someone will be there. This not only gets the right engineer, but it plots the right SLA…" (OPSMGR-1)*

A second tool that dovetailed with that of decision trees and corroborates the need for complete information (Sauter, 1999) was that of dynamic scheduling. OPSMGR-1 explained this as follows:

> *"…That is about the dynamic recording of a job you get into the realms of dynamic scheduling [where] no individual or human interaction has taken place [but] you manage or plan by exception i.e. you are planning the stuff that does not naturally fit. We can do the dynamic scheduling with the detailed asset information or the hierarchies the drop off that…" (OPSMGR-1)*

It may be implied here that the respondent references to a system with such advancement and detailed asset information make the decision-making process possible. Utilising such a system with advanced functionality enable FM operations to adhere to processes consistently and plan accurately. This was noted by PLNR-3 in the following comments:

> *"…Yes we have a software that we use is MAXIMO™ a lot of information is stored on that, and that is used for the end to end process…" (PLNR-3)*

> *"…We can run reports through our systems. We have got an Infoview™ system, which pulls data out from the Maximo™ software that we use to plan. Which tells us the start date whether we have failed [or] achieved SLA, how quickly the job has been opened, and billing process and things like that. So all the data is opened for anybody…" (PLNR-3)*

D.2 Productivity

This section explores the sub-theme productivity within the context of factors influencing information quality. 8.18 % of the references in relation to influence of information systems were coded for productivity. This was accounted for by 66.67% of the respondent in the interview.

The question "Does information technology increase productivity?" has been a controversial and divisive question raised by researchers in the field of information technology and economics. Large and substantial variations on opinions of the level of productivity that can be achieved with information technology exist. This has been termed the productivity paradox (Brynjolfsson, 1993; Brynjolfsson & Yang, 1996; W. T. Lin & Shao, 2006).

Productivity has been defined as the ratio of what is produced to what is required to produce it, which is the average measure of efficiency (Kendrick & Frankel, 2016; Syverson, 2011). This has been fostered by the development of modern science and the quickening of technological innovation (Kendrick & Frankel, 2016). According to Kendrick & Frankel, (2016) productivity is used to measure efficiency as a means of assessing the uses to which resources are being put. This is influenced by several factors such as labour, raw material, capital facilities, education and skills of the labour force and the level of technology (Kendrick & Frankel, 2016). Kendrick & Frankel, (2016) noted that for productivity to be achieved, these factors would have to be positively correlated.

With specific focus on technology, Brynjolfsson & Yang, (1996) posited that productivity is the fundamental measure of a technology contribution, while King, (2007) corroborates this by indicating that productivity can be largely attributed to application of information technology. However, evidence suggests that information technology has little influence on productivity M. M. Brown, (2015). This view has also been maintained by Karr-Wisniewski & Lu, (2010) who indicates that increased usage of technology tools does not always lead to increased work productivity. Several factors have been associated with the productivity paradox, which include the quality of information held by the technology (Sheng & Mykytyn, 2002).

Evidence from the interview suggests that, albeit widely adopted, the quality information and its utilisation were affected by the technology used, which had a knock-on effect on productivity. One such device was the portable digital assistant (PDA). PDAs was observed to be an important factor that influences information utilisation. PDAs are portable handheld device that receive data and information about aspects of FM operations. A challenge of information utilisation, while using PDAs, was the ability to log the data in formats that was accessible i.e. visible, legible and interactive, to the user. This was highlighted as follows by OPSMGR-1:

> *"…That information logged so can it be logged in such a way that it can be seen on a PDA, is it going into your long description, is it going into your short description, where is the details held…" (OPSMGR-1)*

The problem of reporting and displaying information properly was highlighted as an issue that often led to productivity problems measured by meeting aspects of service level agreements (SLA). This was highlighted by PLNR-2 and PLNR-4 as follows:

"…Yes there are a lot of failures, the tools that the engineers have got like the PDAs that can't view the job properly that can't see the SLA so SLA get failed we are measured on our SLA…" PLNR-2

"…the factor that affects efficiency is the way the FM request are reported most definitely and also the relationships with our subcontractor or the lack of choice of subcontractor…" (PLNR-4)

PLNR-2 also noted further that the lack of engineers having PDAs also affects information utilisation in AM programs and subsequently the level of productivity. It was observed that there is a need for real-time reporting which seeks to provide timely information to the system and improve productivity. Having real-time information available at any time can reduce lead-time as well as increase accountability for tracking purposes (Titus & Bröchner, 2005). Such timely information is used for effective decision-making in AM programs. However, real-time reporting was observed not to be achieved due to challenges experienced with the technology used as noted by PLNR-2:

"…We got a backlog of jobs that needs to be cleared. Some of it is due to it issues where engineers do not have PDA. So when we closing jobs down on the systems, which again takes time, we aim to do real-time reporting but obviously if you have got few engineers with no PDA that is a massive amount of work to start sitting there shutting jobs down. So that is something that is done when you have time so then it seems you have missed SLA…" (PLNR-2)

Though PLNR-2 indicated that limited availability of PDAs for operatives were due to IT issues, PLNR-3 went further to indicate that issues concerning the cost associated with providing access to PDAs was limiting the availability of the technology to a wider group of personnel engaged within the operation. This view was encapsulated in the comment by PLNR-3 as follows:

"…For subcontractors but with subcontractors obviously we are not going to spend that amount of money on giving them all PDA and things like that. I think once again it is something that needs to be adaptable to the situation at…" (PLNR-3)

D.3 Resource Utilisation

This section explores the sub-theme resource utilisation within the context of influence of information systems. 5.45% of the references in relation to f influence of information systems were coded for resource utilisation. This was accounted for by 33.33 % of the respondent in the interview.

Labour is a principal resource used in AM programs by FM to convert inputs into outputs in the form of goods or services (Wild, 1983). The effective use of these resources is further contingent on the quality of information produced by the information technology adopted as noted under the productivity theme. According to Wild, (1983), managers are concerned with the effective use of resources in the conversion of inputs to outputs. However, as observed from the interview, aspects of the technology used i.e. PDA, influenced the utilisation of resources. Since PDA require an input from users, such inputs affects the outcomes of AM programs in FM operations. Certain types of behaviour were identified in this context such as users inputting misleading information into the PDA as noted by OPSMGR-1:

"…Engineers will arrive on site and will start the clock running via his PDA. If he was still there an hour later, he will hit a button on his PDA that button would ask him to describe how long he expects to still be there…probably he will hit 60mins so that then alerts the system to say he is going to be there an hour but he is going to be there 2hrs. So we don't have the information. We have PDAs often not used effectively. That does not allow us to know where people are. We don't have a view of all information.…" (OPSMGR-1)

And engineers not liked being monitored as noted by OPSMGR-1:

> *"…Engineers dislike the fact that PDA can almost tell somebody where there are all the time losing the flexibility to work…" (OPSMGR-1)*

> *"…Because we get our calls manually it depends on what information customer can give and what the planner can take from the customer as well…" (PLNR-3)*

> *"…But actually you need to tell the client because they are not giving us information and they are making it more difficult for us to carry out the work for them in the first place. So there is nothing being done about that…" (PLNR-4)*

4.1.2 Organisation Domain

The organisation domain, succeeding the information domain and preceding the people domain (discussed subsequently), details the processes and structures that facilitates the quality information within AM. The question asked in this domain was: "what factors do you consider to affect or influence the quality of information based on the organisational process, procedures, and structure". Within this dimension, four main themes have been identified (Table 4:3 and Figure 4:5) which include:

1. AM processes
2. Data analysis
3. Organisational Processes
4. Resource

Table 4:3 Identified factors influencing asset information within the organisation domain

Theme	Sub-Theme	Sub-Theme Code	No of Respondent	References	% No of Respondent	% References
AM Processes	Asset Lifecycle Analysis	AssetLCA	4	8	44.44%	10.67%
	AM Structures	AssetMgtStruc	4	12	44.44%	16.00%
Data Analysis	Need for Statistically Backed Analysis	NeedforStatBkdAnalys	4	8	44.44%	10.67%
Organisational Processes	Establishing Standard Processes	EstStdProd	6	14	66.67%	18.67%
	Accountability and Auditing	AcctbiltyAudt	5	12	55.56%	16.00%
	Management Support Structure	MgtSupptStruc	5	12	55.56%	16.00%
Resource	Diminished Resources	DimResc	4	9	44.44%	12.00%
						100.00%

Sample Size (N)	9
Total References	75

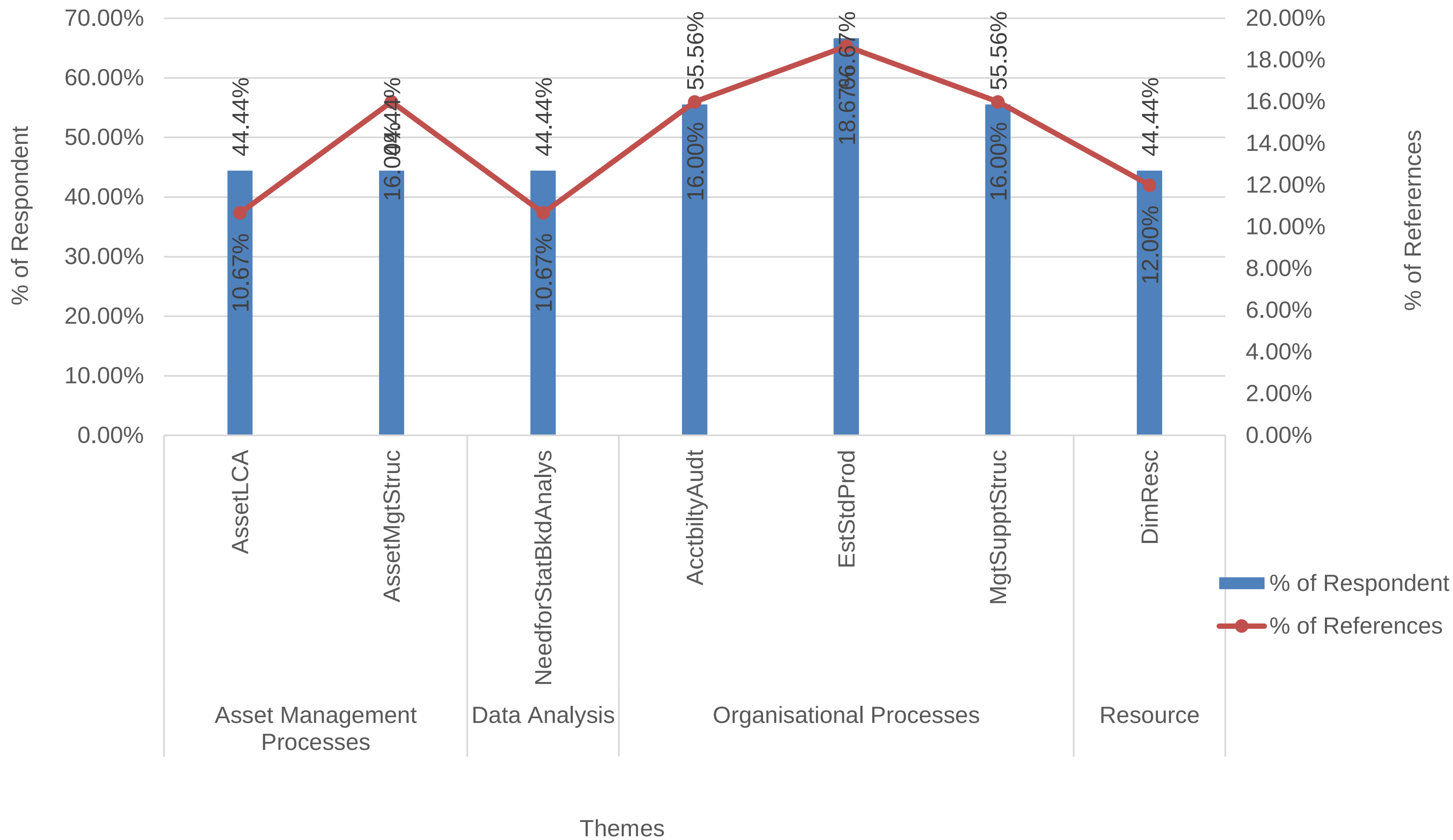


Figure 4:5 Organisation domain thematic analysis showing the percentage of references against percentage of respondent per theme

4.1.2.A AM Processes

AM processes was recognised as a factor that influenced the quality of information of AM programs in FM organisations. Two subthemes emerged as prevailing themes within this factor which were:

1. Asset Lifecycle Analysis
2. AM Framework Awareness

These themes are discussed in detail in the following sections.

A.1 Lifecycle Analysis

Evidence from the study indicates that life cycle analysis is critical to the effectiveness of AM operations. 10.67% of the references in relation to AM processes were coded for lifecycle analysis. This was accounted for by 44.44% of the respondent in the interview.

The life cycle involves several interdependent stages including the identification of the need, the definition of the requirements, design, plan, acquisition, installation, operation, maintenance, rehabilitation and disposal of assets (S. Lin et al., 2007). As an addendum, S. Lin et al., (2007) indicated that this is an information intensive activity of which the quality of data used is paramount. The ability to perform effective AM depends on the analysis of lifecycle. Life cycle analysis (LCA) is a methodology for quantifying inputs to and outputs from product or activity systems (Vigon & Jensen, 1995). This requires substantial information to be collected throughout all stages of a typical asset's lifecycle (S. Lin et al., 2007).

It was observed that life cycle analysis was a concern to FM practitioners as indicated by the respondents. This took a cost conscious focus as to ensuring the items were saved as suggested by OPSMGR-1 as follows:

> *"…Where assets are maintained that are close to the end of their natural life-cycle where replacement might be a more cost-conscious way of maintaining so replacing rather than continuing to maintain*

> *rather than continuing to repair allows the items to be saved…" (OPSMGR-1)*

Though not explicitly stated, the statement implied that asset life cycle analysis was necessary to ensuring the optimal operation of assets.

TheIAM, (2012) presents life cycle analysis as an important pillar in AM operations. This takes the form of acquire, operate, maintain, and dispose (Minnaar, Basson, & Vlok, 2013). According to TheIAM, (2012) life cycle analysis is typically used to determine the interventions that represent the lowest costs. Based on this view lifecycle analysis seeks to help organisations understand the implications of sub-optimal intervention in terms of increased future costs and risks (Minnaar et al., 2013; TheIAM, 2012). This requires the calculation of costs, risks and revenues over the life of the assets or asset systems (TheIAM, 2012).

Based on the responses from the interview, the respondent PLNR-2 indicated the importance of cost factors when considering the aspects of AM. This viewed life cycle analysis as adding value to the service provided. PLNR-2 exemplified this by acknowledging that doing so would save the client the cost of continuous call out charges. This view is encapsulated in the following statement as follows:

> *"…Do you want to look at the bigger picture and say do they want me to look out for say i.e. We have repaired this ceiling 3 or 4 times now and it is getting beyond a joke we are charging for every time they don't need to fix it fully or do you want to leave it and keep charging for it every time they call out because it is a weekly thing and to me if you are giving added value to your client you go and sit down and say listen, it is the 5th time in the past few months we have been to this and it is costing you like £300 every time you go out and you know it will only take £2000 to replace it and in no time it is sorted…" (PLNR-2)*

From this point of view, life cycle analysis is concerned with making the best use of money in the ownership of physical asset by taking into consideration all the cost factors relating to the asset during its operational life (Woodward, 1997). However, the efficacy of LCA as a technique is dependent upon the informational intelligence captured by the organisation (Woodward, 1997). This was found to be lacking based on the evidence provided by the respondent TRSMGR-9 in the study who presented a bleak view of the level of intelligence needed to undertake the requirements of life cycle assessment adequately. This was encapsulated in the statement as follows:

> *"…This sound awful, but there is no supporting intelligence you know. It is all about fixing something and fixing something. There is no understanding...if you are talking about life cycle, for example, there have got no idea what life cycle means, there have got no idea how we manage or measure life cycle…" (TRSMGR-9)*

A factor that affects the ability to harness the potential of life cycle analysis is the quality of information. Studies suggest that the management of data quality must be an integrated part of the life cycle assessment (Weidema & Wesnæs, 1996). This view have been corroborated in other studies that indicate the quality of life cycle is only as good as the information upon which it is based (Vigon & Jensen, 1995). However, evidence from the interview suggests that this is an obstacle to effective life cycle assessment for AM. This view has been encapsulated by TRSMGR-9 in the following statement:

> *"…We do not know anything, particularly about lifecycle budget or analysis. That activity is carried out by the client. They only can utilise their budget based on the level of data we give them, and I don't think that, perhaps, there is enough understanding of what we provide the client for them to make calculated decision about the life cycle of their plant and equipment. There is not enough interaction between the two…" (TRSMGR-9)*

In addition to this ND-7 noted the need for a proper classification of the type of data required for assessment as follows:

> *"…Lifecycle same for our principal really but with asset you want to know when the things are coming up to the end of their life, service history also look is it qualitative rather than quantitative…" (ND-7)*

The information sought by life cycle will involve financial, time-related, and quality data associated with the capital costs of acquisition, design/operational trade-offs and consequential running costs of the asset (Woodward, 1997). Relevant information also needs to be collected to monitor the asset performance in operation and provide a source of intelligence on which to base future decisions (Woodward, 1997). According to Woodward, (1997) it is the data capture and information feedback system which closes the control loop and govern the factor for success or failure.

A.2 AM Structures

This section explores the sub-theme AM structures within the context of AM processes. 16.00% of the references in relation to AM processes were coded for AM structures. This was accounted for by 44.44% of the respondent in the interview.

Too, (2010) indicated that there is a need for a clear implementation of AM processes the within AM operations. According to Too, (2010a), this helps guide the practitioners towards achieving the goal of meeting stakeholder value. This assumes a process view that links asset owners, asset managers, and asset service providers in a mode that permits decisions to be aligned with corporate objectives (R. E. Brown & Humphrey, 2005).

Findings from this research pointed to the fact an established approach to ensuring AM programs was lacking. Two respondents, OPSMGR-1 and PLNR-3, who acknowledged this respectively, confirmed as follows:

> *"…No we don't have a defined framework for AM. We have AM as in we are aware of the assets that we manage or we might be aware of the asset that we manage. Depending, it is on a contract-by-contract basis because in most cases, we start with nothing in terms of AM information, and it is slowly built. Some take little interest in building it, and others take it a greater interest in building it. Framework or processes to support us from an AM point of view, we are building it…" (OPSMGR-1)*

> *"…There could have been a methodology that has been put there. Or whether or not I know what it is, I have not recognised it as a methodology or not. It is just part of my day to day job…" (PLNR-3)*

PLNR-2 further attributes the lack of a structure as an industry-wide phenomenon

> *"…It is opinions; it is not something that is written down it seems to be a whole industry based on opinion and not actual. There are no guidelines to go to…" (PLNR-2)*

This lack of awareness of AM framework is seen to be supported by PLNR-4 who indicates that there is a lack of clarity that is brought about by different opinions for what may be now as an AM framework:

> *"…I have heard people use it around the business and asset registers and that type of thing. In my previous job, there was asset register. But that said I don't know whether that is right or wrong or they were just using the word because that was what they used. Here when I heard them use the terminology and look at whether it is an asset or not, I am not sure if they are talking about just the building or whether it is the all the materials inside the building. I have heard the terminology, and I have seen it being used in different ways, but I would not know which is the right way..." (PLNR-4)*

PLNR-2 presents a confused viewpoint of the use of the terminology in the statement where it can be inferred that the ubiquitous use of the term have resulted in a lack of clarity on what it means.

In contrast to this view, PLNR-3 presented a simplified view of AM as follows:

> *"…To me it is, I would say it is what assets that our customers have that we need to look after. Though it is something that we have agreed to do via a contract. So I think that it is something that is agreed. I think it is more about managing maintenance and then cost, if we can do it in a cost-effective way…" (PLNR-3)*

This point of view as expressed by PLNR-3 takes into consideration cost and maintenance, which are elements of an AM methodology (Amadi-Echendu, Willett, Brown, & Mathew, 2010; TheIAM, 2012)

PLNR-2 further elaborated in the explanation of AM, which predominantly assumes the position of maintenance:

> *"…AM is the management of assets within a building. It is all the small parts and components, how far down do you want to break your assets. Is your asset the room or is your asset the room's contents. Is your asset the ceiling or is your asset what is contained in the ceiling. It is how detailed you want to list your assets, but AM is looking after what is based within the building. It is anything; it is whatever asset somebody chooses to list…" (PLNR-2)*

However, the body of knowledge suggest that this approach to considering AM further obscures the actual purpose of AM (Amadi-Echendu et al., 2010; Povey, 2013; Too, 2010a)

Having a framework is considered to be beneficial in supporting AM programs as this provides individuals with guides to what needs to be achieved. This was highlighted by PLNR-2 as follows:

> *"…I think a structure in everything is important everybody needs a structure but it is all right to deviate from it, but you need to know how to get back on track so you do need a structure…" (PLNR-2)*

PLNR-3 supported the statement made by PLNR-2, by indicating that having a framework will enable individuals deliver what had been agreed within a contract:

> *"…And it is important to have that because we can't just do our all day to day task as when we want. We do have guidelines we stick to such as HSE, risk management, etc. and what we actually promised in our contract…" (PLNR-3)*

PLNR-4 went further in support of a structure that enables the balancing of cost, risk and efficiency by indicating as follows:

> *"…I am not saying that it is important for me to know, but if it is based on the cost, efficiency and risk then I think it is important that it is in place because obviously if that is how we can keep or if it is all balancing one with the other to make sure that the business is running correctly, then that sort of thing needs to be in place regardless of what name it is called…" (PLNR-4)*

> *"…If it was, or I knew more about it, and we are looking at process review, and we could bring the risk, cost and efficiency in then yes, but again not knowing more…it sound like something that could fit in with way things work…" (PLNR-4)*

It can be inferred from this comments that opinion is mixed concerning AM structures. Though it has been acknowledge and agreed that having a structure will be beneficial, strong suggestions indicates that no such structure exist in the industry hence making the method to achieving the outcomes necessary for success diminished.

4.1.2.B Data Analysis

The utility of data analysis depends on the quality of information and appropriate skills. This was recognised as a factor that presented a challenge to AM programs by the interviewed respondents. One subtheme, need for statistically backed analysis, was identified to be the main issue within this context. The succeeding section presents the discussion in relation to this theme, data analysis, by the respondents.

B.1 Need for Statistically Backed Analysis

This section explores the sub-theme need for statistically backed analysis within the context of data analysis. 10.67% of the references in relation to data analysis were coded for need for statistically backed analysis. This was accounted for by 44.44% of the respondent in the interview.

Under the organisational dimension, it emerged that there is the need for statistically backed analysis by FM organisation. Analysis enables operators determine areas of concerns and seek relevant course of actions to it. A core principle of AM is effective decision making. This occurs in the form of analysis that enables managers take actions that add value to the organisation based on the quality of data. This requires the quantitative justification for decisions being implemented (Minnaar et al., 2013). Consequently, effective AM is a data-centric process enabling it achieve the stated objective (Amadi-Echendu et al., 2010; Gallaher, O'connor, Dettbarn, & Gilday, 2004; S. Lin et al., 2007). Data-centric AM refers to the use of quantitative methods to decision making which involves statistical data analysis (Minnaar et al., 2013).

Data analysis encompasses many techniques, which include descriptive statistics and exploratory data analysis (Minnaar et al., 2013). An example of such a data analysis method has been indicated by SUTMGR-8 in the following statement:

> *"…So we have correlation lines for energy consumptions and if they set outside the parameters that will trigger us to have a little to see if there is any spike from the norm and we will investigate…" (SUTMGR-8)*

However, Minnaar et al., (2013), commented that data analysis is still a profound a challenge to asset managers. Evidence from the interviews observed that practitioners of AM in FM industry have little proficiency at performing analysis, as a consequence, analysis are seldom performed which impair the right decision being made. For instance, OPSMGR-1 acknowledged the weakness of the industry in carrying out analysis as follows:

> *"…So being able to provide those comparisons from the information within the operating system that is what we are designed to do in terms of providing FM services how much we do of that, how detailed we can get. We could do better in that situation but from my understanding and experience from other FM providers we are all pretty much in the same boat, we can't always easily deliver the analysis that tells you what you should do as an organisation…" (OPSMGR-1)*

The inabilities to perform such analysis have been attributed to the actions of individuals who may neither see the need for utilisation of information nor have the abilities to use information in useful ways. This has been emphasised by OPSMGR-1 as follows:

> *"…The systems allow you to provide all that information or record that information. The facility is there to do it. The question is how much of that that you do…" (OPSMGR-1)*

OPSMGR-1 further made it clear that AM should be supported by the analysis of data within the system which supports the notion of (Minnaar et al., 2013):

> *"…I think it should be more statically backed-up of the analysis of data within the operating system…" (OPSMGR-1)*

Despite this suggestion, the use of data is subject to the operational activities of the individual party or parties participating in the activity of the organisation, which is a characteristic of FM organisation practising AM (Atkin & Björk, 2007). For instance, ENVADV-6 noted that:

> *"…Organisations like seeing data in different ways and they go away and use it for whatever they want...they will all do their own reporting structure, and there will be advantages and disadvantages for that…" (ENVADV-6)*

As a result, there is little incentive for individuals to spend time in performing analysis. Consequently, a lack of the relevant skills set as required to carry out any form of analysis for AM is missing. This has been acknowledged by TRSMGR-9 as follows:

> *"…No we don't understand information. We are no good either in carry out an analysis and review. We generate lots of information that nobody has the time to read or to act upon. I think that is one of the fundamental problems. Because again there is no analyst. There aren't people that understand statistics or take the time to trouble, trend or root cause anything..." (TRSMGR-9)*

TRSMGR-9 further added:

> *"…What impact does breakdown have on the plant and equipment, why was there a breakdown. There is not enough collaborative data collection and analysis for us to understand that at all. We go on and keep repairing something because that is what we do…" (TRSMGR-9)*

4.1.2.C Organisational Processes

Organisational processes was recognised as a factor having an effect on the information used in AM programs. To this end, the following subthemes were identified and are discussed in the following sections:

1. Accountability and Auditing
2. Management Support Structure
3. Establishing Standard Processes

C.1 Accountability and Auditing

This section explores the sub-theme accountability and auditing within the context of organisational processes. 16.00% of the references in relation to organisational processes were coded for accountability and auditing. This was accounted for by 55.56% of the respondent in the interview.

The ability to be accountable and auditable is regarded as the key benefits of having documented processes and controls (BIFM, 2010b). Providing more accountability and maintaining audit trails enables established processes to achieve their potential (Al-Mashari, 2001). It was observed that respondents' highlighted accountability and auditing under processes attribute as being an issue. Auditing refers to the methodical examination or review of a condition or situation (TheSage English Dictionary and Thesaurus, 2014). This is relevant as it aims to examine carefully for accuracy with the intent of verification of issues relating to process deviations. This study showed that auditing was not well-established in practice. This was highlighted by the following respondents; OPSMGR-1 and TRSMGR-9 in the statements as follows:

> *"…I suppose if you don't know what you did because you can't audit what you did you don't know what you should be doing so you can't always identify the most efficient way of working. You can't or test or time how long certain part of the process take again you, therefore, can't influence how efficiently you work..." (OPSMGR-1)*

"…Would be that you need processes and procedures you write them you put them onto the standard (our) way of working…but know body know they are there. There is never any monitoring…there is no effective auditing to ensure that we do what we say. And this presents another problem…" (TRSMGR-9)

It was further observed that personnel did not adhere to processes and thus were not accountable due to the lack of auditing. For instance, this was highlighted by ND-7 who indicated reference to processes was not regularly made as follows:

"…Generally [what] happens is they looks straight to the forms they don't regularly look at the process diagrams until is actually came down to audit time and then an issue is we be running around trying to find how we should be doing things…" (ND-7)

Based on this comments, it can be said that FM managers often view process related work as low priority (Amaratunga, Haigh, Sarshar, & Baldry, 2002). However, TRSMGR-9 further attributed the lack of accountability as an effect of being measured and monitored. According to TRSMGR-9:

"…I understand fundamentals of why people don't want to follow process and procedures because they are accountable. That is probably one of the main reasons because they are accountable they don't want to be accountable for something that is measured…" (TRSMGR-9)

Such lack of accountability further leads to performance issues as noted by PLNR-4:

"…The misunderstanding of how processes or where processes fits within the chain. Yes, it can affect efficiency because everybody else is waiting for somebody else to do whatever they think they should be doing and in the end that is where the gaps are and things fall through

because nobody take proper ownership and responsibility…" (PLNR-4)

In addition to the lack of accountability, it was indicated that not adhering to processes presented significant problems. This is a view supported by (Alexander, 2008) who indicated that attempts to adhere to a common process are likely to be ad hoc or even chaotic leading to different ways of working. This has been encapsulated in the statement made by PLNR-4 as follows:

> *"…It is not the process themselves it is the way that people are using them. If they are used correctly, they are fine but in some instances, the processes are not adhered to, and that is when things go wrong…" (PLNR-4)*

C.2 Management Support Structure

This section explores the sub-theme management support structure within the context of organisational processes. 16.00% of the references in relation to organisational processes were coded for management support structure. This was accounted for by 55.56% of the respondent in the interview.

It has been reported that good support structures facilitates incremental innovation in organisations (Grover, 1993). Having the appropriate management structures instituted within an organisation increases the quality of information used in AM operations (S. Lin et al., 2007). However, process initiatives have tended to be narrow or partial because they take place within narrow functions and departments rather than across the organisation (O'Neill & Sohal, 1999). According to O'Neill & Sohal, (1999), these lack effective managerial stewardship and are not integrated with the holism of organisational change. S. Lin et al., (2007) further reported that inadequate management structures could impede procedural guidelines for those involved in AM operations.

Two respondents confirmed how the management support influences organisational processes. For instance, PLNR-3 suggested that the configuration of management allows adequate support of the processes instituted. This was stated as follows:

> *"…Well I have a different contact team, and the hierarchy is different so we have engineering managers, supervisors, etc. Where other contracts don't so some of the process implemented on those particular contact don't have that hierarchical support. So sometimes things slip through the net…" (PLNR-3)*

Communication and misinterpretation of process was seen as a significant inhibitor in AM operations. This lack of support from management perspective was highlighted by PLNR-4 as follows:

> *"…So you might have a senior manager having one idea of what the processes and that has not been conveyed down and therefore that part of the process is not dealt with in the way they are expecting because they think the process reads one thing, and we have seen the process reading something else. And that will affect what we do…" (PLNR-4)*

This statement was supported by PLNR-2 as follows:

> *"…Just day to day. Getting jobs done and things not being done correctly because one person got one idea and another person has another idea, and so nothing has been cascaded down into a set process it is just passed along each other, and things get missed and when things change people don't get updated…" (PLNR-2)*

PLNR-4 further added that having such lack of communication presents a major challenge not just from the lower levels but from senior management levels as well and also in managing expectations. It was perceived that such a situation may lead to a Laissez-faire approach to the activities of FM operations. This was exemplified in the comment of PLNR-4 as follows:

> *"…It can be a major challenge because it is not so much the delivering of the work because it is not us to deliver in the first place it is getting whoever expectation managed correctly, and that comes from senior management. So from a management perspective, they probably have more of a challenge than we would we would just carry on regardless and wait till we get told otherwise..." (PLNR-4)*

Further to the effect of managerial support, the structure of the organisation had an effect on the effective use of processes. For instance silo structure of the organisation, where there is little interaction with other units resulted in the lack of process engagement. This was exemplified by ND-7 and TRSMGR-9 in the following statement:

> *"…but some of the site with silos so people are not necessarily engaged with the rest of the business, so it is important to have people interacting with the processes and having a wider appreciation and where their little bit sits within the rest of the system, it might just lead..." (ND-7)*

> *"…I was horrified as to the lack of processes that were available. No standard process, no written standard process and procedures, everybody operated in silos, no process or procedures were the same, and there was no repository to put any process or procedures so everybody pretty did what they thought was best which was not always…" (TRSMGR-9).*

C.3 Establishing Standard Processes

This section explores the sub-theme establishing standard processes within the context of organisational process attribute. 18.67% of the references in relation to the organisational process attribute were coded for establishing standard processes. This was accounted for by 66.67% of the respondent in the interview.

Processes standardisation have been particular interest in the AM (Al-Mashari, 2001). According to S. Lin et al., (2007) AM is process-oriented involving a wide range of disciplines as well as the whole asset life cycle. Standardisation of business processes allows faster information-based decision-making and the improved capability of reducing costs and improving quality (Okrent & Vokurka, 2004). Policies to increase standardisation have been found to be beneficial for businesses operating in innovative industries (Bunduchi & Smart, 2010). However, achieving effective standard process requires a consensual approach (Bunduchi & Smart, 2010). The lack of standard processes has been accounted for waste in resources (Benneyan, Lloyd, & Plsek, 2003). Bhatt, (2000) further argues that the biggest obstacle in performance is the inability to develop standard processes that foster comparison of results. This view is supported by Kumar & Harms, (2004) who indicates that operational efficiency can be improved by developing standard processes.

Under the process attribute theme, 66.67% of the respondent agreed that establishing standard processes would help improve AM programs within the remit of facilities management operations. However, there was a view that such standard processes were developed on a disorganised basis. For instance, OPSMGR-1 indicated the establishment of processes, however on a contract-by-contract basis:

> *"… Yes, we are in the process of doing that, and we will have established facilities management processes by contract as part of that study. In some cases…there is a certain amount of process establishment that is moving on…" (OPSMGR-1-ORG_1)*

This aspect of establishing standard processes on a contract-by-contract basis was also echoed by PLNR-3 and PLNR-4 respectively as follows:

> *"...We do take in the standard process, but again that differs within contacts as in what your contact wants from our facilities management and what we can really deliver..." (PLNR-3)*

> *"…There are established processes in place. Again contract dependent, some of those processes will be different…" (PLNR-4)*

In contrast to this, ND-7 advocated a collaborative approach to process establishment albeit from a functional perspective:

> *"…You need from a supporting; I will call it enabling functions so of the finance, human resource, environment, health and safety. So all those domain operational guys come and create the [process]…" (ND-7)*

Therefore, process standardisation should be carried out on a corporate basis (Kumar & Harms, 2004).

It was noted that there is a lack of processes established within facilities management operations. A lack of process indicates that activities were not consistently performed thus creating a situation where individuals employed several alternative and non-prescribed methods to the activities. In such a situation, the quality of information can be adversely affected. This was indicated by PLNR-2 as follows:

> *"…Put proper processes in place so people know what they are doing. Keep it on our main drive system. There have never been proper processes written and put down on paper where everybody can view it. So to me, that would be the correct way of doing it where in the process you can know what you should be doing, and you know that it is done correctly and done in the same way and no one has their own individual quirks of doing it one way or the other. Then you can point out to people*

that it has been done incorrectly and you have a proper defence to say it is not done correctly…" (PLNR-2)

It was observed that having a set of core processes in place provides a point of reference for activities within facilities management which enables individuals perform their work well. This was indicated by PLNR-2 as follows:

"…Having a process will help me perform my work better. The reason is because we are working as a team so as people are moving in and out of the team then if there is a question there is a set core process for them to refer to then it is easier they could get on with it…" (PLNR-2)

PLNR-2 further indicated that such processes offers greater potential whereby there is a feedback mechanism throughout the operations and where a change occurs, such change is date-stamped to ensure its consistency of use. This has been described as follows by PLNR-2:

"…Moving to a different process where basically where there is a set process a core process, which everyone refers to and if that change, it is cascaded down, and it is fed-back, and everyone has understood the process and moving forward that is how it would be done. But it needs date stamping, and this is it and moving, and if you change date, you date stamp it again so you know that you are always with the newest process…" (PLNR-2)

ND-7 highlighted the effect of standard process on the efficiency of the operations. This view supports the notion posited by (Kumar & Harms, 2004). ND-7 indicated as follows:

"…So it is important to have people interacting with the processes and having a wider appreciation and where their little bit sits within the rest of the system, it might just lead to more efficiency. The process points you to the person for a different task…" (ND-7)

4.1.2.D Resource

Resources within the context of the interview referred to the human resource available to FM. It was recognised this had an effect on the quality attribute of information used in AM. One subtheme explained this factor and is presented in the succeeding section.

D.1 Diminished Resources

This section explores the sub-theme diminished resources within the context of resource. 12.00% of the references in relation to the resource attribute were coded for diminished resources. This was accounted for by 44.44% of the respondent in the interview.

AM has been regarded as a resource intensive activity, which requires the significant allocation of people to ensure all activities are performed to the required standard. However, (S. Lin et al., 2007) reported that limited resources are often deployed thus creating operational issues. As reported by (Too, 2010a) the key challenge for AM is maximising efficiency and effectiveness of organisation resources. Diminished human resources have been found to be a cause of poor information quality affecting AM operations (Feinstein & Morris, 2010; Too, Betts, & Arun, 2006; Woodhouse, 2001). S. Lin et al., (2007) further supports this indicating that personnel management and other organisational factors affect the ability to maintain information quality. Based on these assertions, this study has identified similar challenges within the organisation interviewed.

Under-resourcing in FM is, however, a multi-layered challenge and can be attributed to economic or operational pressures. For instance, OPSMGR-1 and ND-7 cited economic pressures resulting in fewer staff:

> *"…I think it is industry wide because contracts come up to tender quite frequently. There is a lot of pressure to undercut the opposition…" (OPSMGR-1)*

"…The high cost comes into our competitors but when we do win we find out that our margins are quite narrow. So it is usually a matter of being quite clever with our staff and where they are based…" (ND-7)

These statements surmises the assertion by Bungar, (2012) and (Woodall et al., 2012) who indicated that many FM organisation are achieving higher staff turnover at lower margins as significant pressure on cost-reduction remains a feature of FM contracts. Operationally, the level of resourcing has also been attributed to circumstances that result in staff departure as indicated by PLNR-3:

"…Yes and that is due to resourcing. It is not a business failure or anything like that. It is just circumstantial, we have had engineers leave, and staffs leave, and resources are a bit diminished…" (PLNR-3)

Whatever the circumstance, this has an impact on the quality of work performed. This instance noted by ND-7 and PLNR-3 indicated that FM being under-resourced has an effect in the quality of work that is done as well as the process being performed:

"…What I have also found out is that a lot of FM is under-resourced in terms of staff on the basis that a lot of the contract they bid it for on a bit of shoestring really just to try and win. I mean it is very tight so a lot of the time you spending a lot of your time doing calls compared to thoroughly doing it properly…" (ND-7)

"…As I mentioned about resource it is so dependent on the processes if the processes are interrupted or altered in any way. Any process has a high level of the human element and there will always going to be a weakness there. You are very dependent on the next person to carry out what you have asked them to do…" (PLNR-3)

An observation made regarding this issues was the effect it had on those having to perform tasks relating to AM. This increases the pressure on those having to perform relevant task resulting in diminished attention to detail such as diminished planning, diminished troubleshooting, diminished understanding, and acting reactively. This have been expressed by ND-7 and TRSMGR-9:

> *"…You get aspect that it also reduces the time that people take to plan, and the way things should be done and I am not saying like necessarily cut corners, but it is human nature just to try and, you know you have a task and several other tasks that are ahead of you are always trying to, where possible, recover the time you have got…" (ND-7)*

> *"…Because the more under-resourced you are, the less approach they take less time they take to ensure that things are done properly because they haven't got that time to stand back and reflect or to undertake training or that kind of thing…" (TRSMGR-9)*

> *"…They are always understaffed so that means that you are always acting reactively. You don't have the time to study and analyse and root-cause you don't have the time to be proactive because it is a reactive business because of the lack of competent resource…" (TRSMGR-9)*

4.1.3 People Domain

The people domain focuses on the individual's concerns, for example, the issues of job description, job security, motivation, education and training, and psychological needs (S. Lin et al., 2007) and how these influences asset information quality. The question posed to the respondents was as follows: "with reference to people factors such as skills, training, motivation, what factors do you consider to affect the quality of information". Three themes were identified which are:

1. Behaviour
2. Development
3. Skills

These are represented in Table 4:4 and Figure 4:6 respectively.

Table 4:4 Identified factors influencing asset information quality within the people domain

Theme	Subtheme	Subtheme Code	No of Respondent	References	% No of Respondent	% References
Behaviour	Proactive Engagement	ProcEng	3	5	33.33%	20.83%
	Self-Esteem	SelfEst	2	4	22.22%	16.67%
Development	Training and Educating Data Stakeholders	TrngEduDatStake	4	10	44.44%	41.67%
Skills	Balanced Skill Base	BalSkillBas	3	5	33.33%	20.83%
						100.00%

Sample Size (N)	9
Total References	24

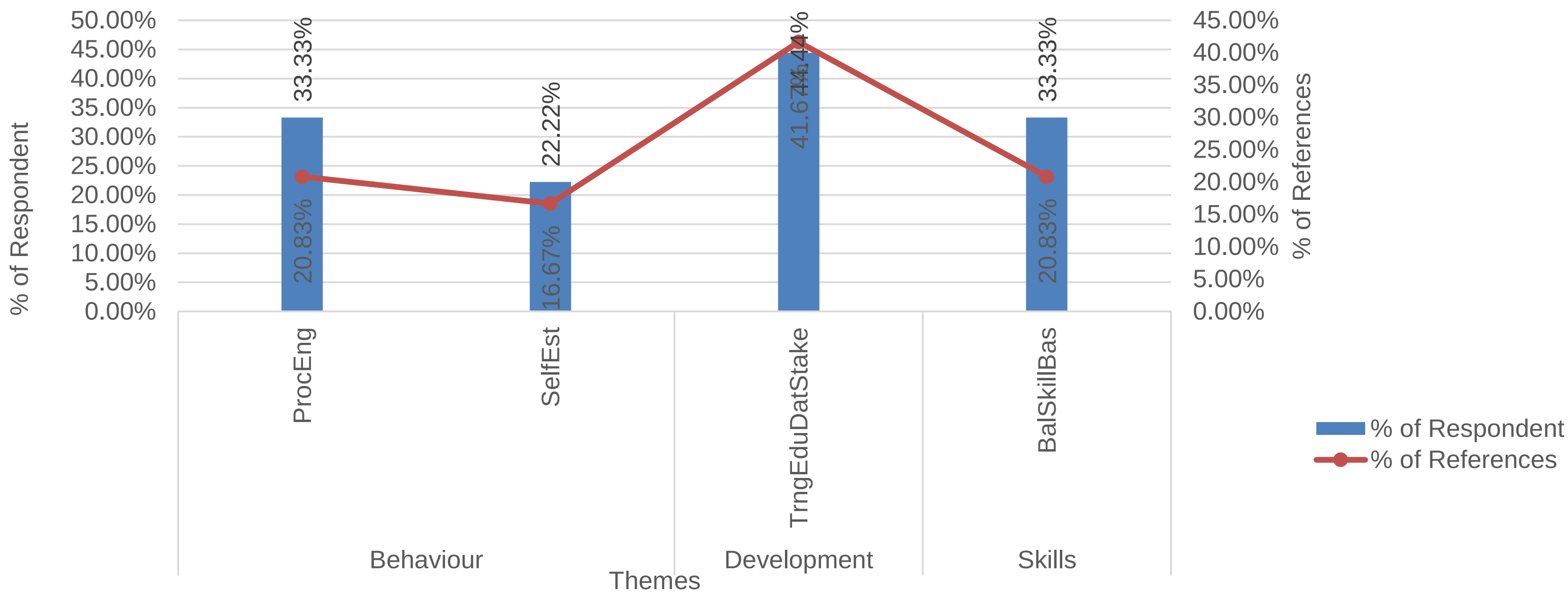


Figure 4:6 People domain thematic analysis showing the percentage of references against percentage of respondent per theme

4.1.3.A Behaviour

Behaviour, which refers to the aggregate of the responses or reactions made by individuals in any situation, was determined to be a factor having an effect on the quality of information used in AM program. Based on the responses by the respondents, two subthemes: (1) proactive engagement, and (2) self-esteem, were identified to influence behaviour. These are discussed in the succeeding section.

A.1 Proactive Engagement

Under the behaviour attribute theme, 33.33% of the respondents recognised "proactive engagement" (20.83% of responses) as a factor that impinges on the quality of information in AM programs within facilities management operations.

The strategic nature of AM considers the proactive commitment of managers and personnel (Too et al., 2006). According to Too et al., (2006) more attention is devoted by asset managers to a very broad range of concerns that combines engineering principles with sound business practices, information management and economic theory. This provides a better understanding of how to align an asset portfolio so that it best meets the service delivery needs of customers (Too et al., 2006). Conversely, Zuashkiani, Rahmandad, & Jardine, (2011) reported that due to entrenched cultural behaviours, managers find it difficult to move from a reactive to a proactive culture. Notwithstanding, a proactive approach hold significant potential to improve the quality of information, and thereby the value of AM. For instance, respondents acknowledged the benefits of proactive engagement in the ability to gather timely information, which influences the outcomes of AM programs. By proactively identifying areas of concerns, OPSMGR-1 indicated that problems on sites can be immediately called in thus providing a timely resolution of problems. This is stated by OPSMGR-1 as follows:

> *"…Rather than we just respond and react to request, can we proactively prevent problems in the first place? The PPM schedule itself is one thing but also whether you can provide service on site to find the problems before they become problems, the building inspection for*

> *some site we are finding things that are likely to go wrong…" (OPSMGR-1)*

Despite proactive engagement being beneficial, stakeholder engagement is however required. In this regards, management support is essential (Zuashkiani et al., 2011). This has been specified by PLNR-3 as follows:

> *"…If a planner comes up with an idea for example and goes to management and say what do you think if it works, great it will be implemented if it is not it doesn't you carry on as normal..." (PLNR-3)*

It was also observed that by employing proactive engagement, timely information, which is a dimension of data quality, can be achieved thus having a positive influence on AM programs. According to PLNR-3, this has enable the achievement of significant progress within the operations as indicated by the statement:

> *"…The things I have implemented that has been quite successful. For example, real-time reporting that needs the subcontractor to phone me when they go on site and when they leave site I can have an instant update and things like that. That has improved our SLA by about 25%..." (PLNR-3)*

A.2 Self-Esteem

Under the behavioural attribute theme, 22.22% of the respondents recognised "self-esteem", accounting for 16.67% of responses within the people domain, as a factor that impinges on the quality of information in AM programs within facilities management operations.

Self-esteem is a concept of a feeling of pride in yourself (TheSage English Dictionary and Thesaurus, 2014). It has been noted to be a significant psychological attributes that increases the productivity of personnel (McLean & McNeice, 2012; Pollock & Colwill, 1987; Scope, 1988). The theory of and the effect of self-esteem was identified by Maslow, (1943) based on the hierarchy of human needs. According to Maslow, (1943), satisfaction of the self-esteem need leads to feelings of self-confidence, worth, strength, capability, and adequacy of being useful and necessary. These needs are based upon real capacity, achievement and respect from others (Maslow, 1943). Frustrating these needs produces feelings of inferiority, of weakness and of helplessness giving rise to basic discouragement (Maslow, 1943).

McLean & McNeice, (2012) observed that when participant in an organisation are empowered by building their self-esteem, there is an active engagement in the design and delivery of all tasks. Badger, Ph, & Garvin, (2007) also noted that self-esteem affects learning and learning enhances self-esteem.

Based on these arguments, the observation on self-esteem from the study was mixed but had a significant influence on the operation of the organisations investigated. For instance, ENVADV-6 indicated fear and resistance to change as a challenge:

> *"…In every single organisation people just don't want to believe they don't want to challenge the status quo, they are afraid I think but don't want to admit it, and that change is bad when I think change is very good…" (ENVADV-6)*

This observation corroborates the arguments put forward by (Maslow, 1943) with regards to the effect of repression of the factor that encourages self-esteem. Other participants, however, indicated a collaborative and motivational attitude to enhancing self-esteem to improve on personnel output. Such as creating a wider understanding, as noted by ND-7:

> *"…What we can have is a wider understanding or why we actually prescribed certain ways of doing things so they have seen the wider picture or feeling like they are part of a wider interconnected set of people who are working for the same kind of goals…" (ND-7)*

While TRSMGR-9 noted inclusive as follows:

> *"…Until you sit people down and get to appreciate what they do and what impact that has upon, the end user, then there is the realisation that they are doing something very worthwhile. So in general, they have got quite a low esteem…" (TRSMGR-9)*

> *"…So in general, they have got quite a low esteem, and they start to talk to them about the concept of what they do and deliver and how that has an effect on generally people, they start to appreciate that what they do is important, and it gives them self-worth, they feel better valued…" (TRSMGR-9)*

With reference to motivation, ENVADV-6 noted as follows:

> *"…You have got to motivate people and talk people that are doing that level of activity so that you can get the very best out of them looking at what has been going wrong, and how we can prevent it…" (ENVADV-6)*

4.1.3.B Development

Development refers to the act of improving stakeholders' involvement within the process of AM. To this end, training data stakeholders emerged as a significant theme. This is discussed in the succeeding section.

B.1 Training and Educating Data Stakeholders

Under the development attribute theme, 44.44% of the respondents recognised "training and educating data stakeholders" (41.67% of responses) as a factor that impinges on the quality of information in AM programs within facilities management operations.

Training, education, and knowledge of data stakeholders of AM have been linked to the success of AM (Chareonsuk & Chansa-ngavej, 2010). These stakeholders include data collectors, data custodians, data managers, and data consumers (S. Lin et al., 2007; Sebastian-Coleman, 2013). However, S. Lin et al., (2007) reported that specific challenges exist with reference to training stakeholders on the relevance of quality information. Zuashkiani et al., (2011) reported that training has been impacted by financial pressures within organisations hence leaders seek means to reduce the investment made on training. Less investment in training reduces abilities of personnel leading to lower quality and less efficient use of resources (Zuashkiani et al., 2011). However, the evidence from the study indicates that training key stakeholders have a positive effect on the quality of information when reporting. For instance, it was observed that the delay in reporting jobs resulted in the inability to complete tasks on the system thus missing on key SLA. This was overcome by educating the data providers on the importance of reporting jobs in a timely manner. This has been evidenced by PLNR-3 as follows:

> *"...Yes it is going back to education and knowledge. I know recently when I first started on my contract the engineers were very aware of how important reporting back jobs were so things were staying open on the system that will likely fail the SLA when merely it was just the case of telling them on how to report the job properly. So we rolled that out, and that worked well..." (PLNR-3)*

This view supports the position held by Chareonsuk & Chansa-ngavej, (2010) which suggest that when organisations improve its human resources by way of training and employee engagement, the effects are more directly felt in its business performance. PLNR-3 and TRSMGR-9 further acknowledged and emphasised the relevance of education, which supports the view of Chareonsuk & Chansa-ngavej, (2010), within FM operations as follows:

> *"...Obviously, we know what we need to put in into the system to get the job going it relies a lot on the training of new staff really..." (PLNR-3)*

> *"…I think it boils down to education why, what, when and how you need the information to be collected. There has to be a better understanding*

why people need to report details and then what are the benefits of reporting that detail…" (TRSMGR-9)

It was acknowledged that the impact of insufficient information results in rework and time wastage as identified by PLNR-4. However, PLNR-4 indicated educating the reporter as necessary within this context. PLNR-4 suggested that providing a structured method for collecting information guarantee the information provided would be sufficient for the work to be performed and foster swift decision-making. This has been indicated by PLNR-4 in the statement as follows:

"...The majority of our work orders are reported via a third party to site access. So the client helpdesk will log the job, and the job will be logged with two words. So I would educate the people who are responsible for reporting 80% of the job through. Because 80% of those jobs you end up having to go back to ask them questions. Not only is it taking my time it is taking their time because they have to answer my questions again. So I would find a way or even templating what should be given automatically. So the more information that we have, the easier it is to make a decision and the faster it is to get the work order through the system..." (PLNR-4).

PLNR-3 went further to echo PLNR-4 comments with the emphasis on education but, however, added the need for strict adherence to policies as follows:

"…I think it is a case of re-educating and constant education, or refresher course or things like that to adhere to stated policies. Obviously…re-education and reinforcement… (PLNR-3)

Though S. Lin, Gao, & Koronios, (2006) posits that lack of training can have an adverse impact on information quality. It was acknowledged that educating the users on the relevance of the information provided will be beneficial in enabling users and recipients of information obtain the better value of the information that is being provided. This has been put forward as a solution as by PLNR-4 in the following statement:

"…Probably an education process of getting people to understand what they are actually reading and actually take it in because people will look at it and not actually use it and may not actually give it in the first place. Some kind of education could help…" (PLNR-4)

4.1.3.C Skills

Skills refers to the ability to produce a solution in some problem domain which has been acquired by training. This was encapsulated in the theme having a balanced skills base and considered by the respondents to have an effect on the quality of information. The following section explains this phenomenon.

C.1 Balanced Skills Base

Under the skills attribute theme, 33.33% of the respondents recognised having a "balanced skill base" (20.83% of responses) as a factor that influences the quality of information in AM programs within facilities management operations.

People's skills and abilities to use the system efficiently are very critical AM operations (S. Lin et al., 2007). According to S. Lin et al., (2007) a perfect system would not be able to produce high quality information if people do not have the right skills and knowledge to control the system. The implementation of AM principles further requires agents to develop new skills to cope with the various challenges of effective infrastructure AM (Schraven, Hartmann, & Dewulf, 2011). Such skills thus should not be limited to technical skills but include a mix of soft skills as well (Schraven et al., 2011; Woodhouse, 2003). Example of these include policy making skills, communication skills, effective making skills etc. Woodhouse, (2003) argues that such skills should not be the remit of top management but should be permeated throughout the hierarchy of the organisation.

The research finding under skills attribute theme showed that 33% of the respondent indicated that having the right skill qualification within FM operation would enhance the quality of information provided for AM programs. Though it was indicated that data producers might not be qualified technically to provide the necessary information required to enable the adequate execution of AM programs as suggested by OPSMGR-1 as follows:

> *"…Reporters of problems won't necessarily be technically qualified to be able to identify what problem is…" (OPSMGR-1)*

With the introduction of data producers who have the right aptitude to provide and interpret technical information, there is the potential to improve service delivery. This has been indicated as follows by OPSMGR-1 and PLNR-2 respectively:

> *"…If you can get some technical qualification before the job get to an engineer you are improving the chances of delivering the best customer service…" (OPSMGR-1)*

> *"…So it is asking the correct question and if it is, or does seem it is quite technical, then have a line of more technical people to deal with the call and again ascertain what it is and coming out to fix it…" (PLNR-2)*

TRSMGR-9 went further to state that not only is the requirement for technical skills necessary but other softer skills, such as managerial skills, is necessary for the effective coordination of AM. this view supports Woodhouse, (2003) position:

> *"…I think that FM should be managed with more general management skills rather than it left to the technical management team to manage the business I think that you have got to do that to have all of those touchy-feely process, people, good communication. I think that there is going to be a more balanced management structure so that you have got a cross section of supporting skills rather that sit and talk about pump and what hasn't worked and more so how that affects the patient and what can we do to prevent it happening…" (TRSMGR-9)*

4.2 RO3 – Identify the Information Quality Attributes Specific to AM in Facilities Management Operations

IQ are derivatives of the relationships that exist between social actors and their socio-technical environment. Therefore, obtaining the viewpoints of the actors with reference to perceived quality of information is crucial. Existing studies suggest that practitioners evaluate IQ based on specific dimensions (Sebastian-Coleman, 2013; R. W. Wang et al., 1996). However, there is limited evidence of the classification of IQ attributes in the field of AM. Hence this sections seeks to establish the IQ attributes used in AM programs undertaken by facilities management practitioners.

As described in the previous section, qualitative data analysis was further performed to identify the IQ attributes associated with AM activities. Data was collected from the interviews and were coded based on a deductive and inductive coding scheme (Kulatunga et al., 2004). Deductive coding involved using predetermined IQ attributes identified from the literature review while the inductive coding allowed for categories to emerge from the interview transcript (Kulatunga et al., 2004). The interviews were subsequently analysed to identify relevant IQ attributes. Based on the findings of this process, the IQ attributes identified closely matched those identified in the literature. The percentage (%) relative frequency of occurrence of IQ attributes was computed to determine the frequency of each occurring attributes (Appendix VI)

The result presented IQ attributes, which had most references by participants in the study. In total 71 IQ attributes were determined from the interviews (Appendix VI). In addition to this, seven (7) quality attribute were deemed to be most important to the operations of the respondents due to the high levels of references made to those qualities (Table 4:5 and Figure 4:7). Therefore, it is suggested that these attributes as indicated by the respondents hold very significant values towards performing AM activities. It also goes to suggest that these are the most important attributes of IQ the respondents actually considered in their evaluation of information. However, this analysis did not seek to determine the reason why these attributes were important in this context.

Table 4:5 Frequency of Occurrence of IQ Attributes

No	Data Quality Attributes	% Relative Frequency (Importance Level)
1	Accessible	4.27
2	Accuracy	9.95
3	Correct	3.79
4	Current	3.79
5	Detailed	7.11
6	Timeliness	3.79
7	Visible	3.79

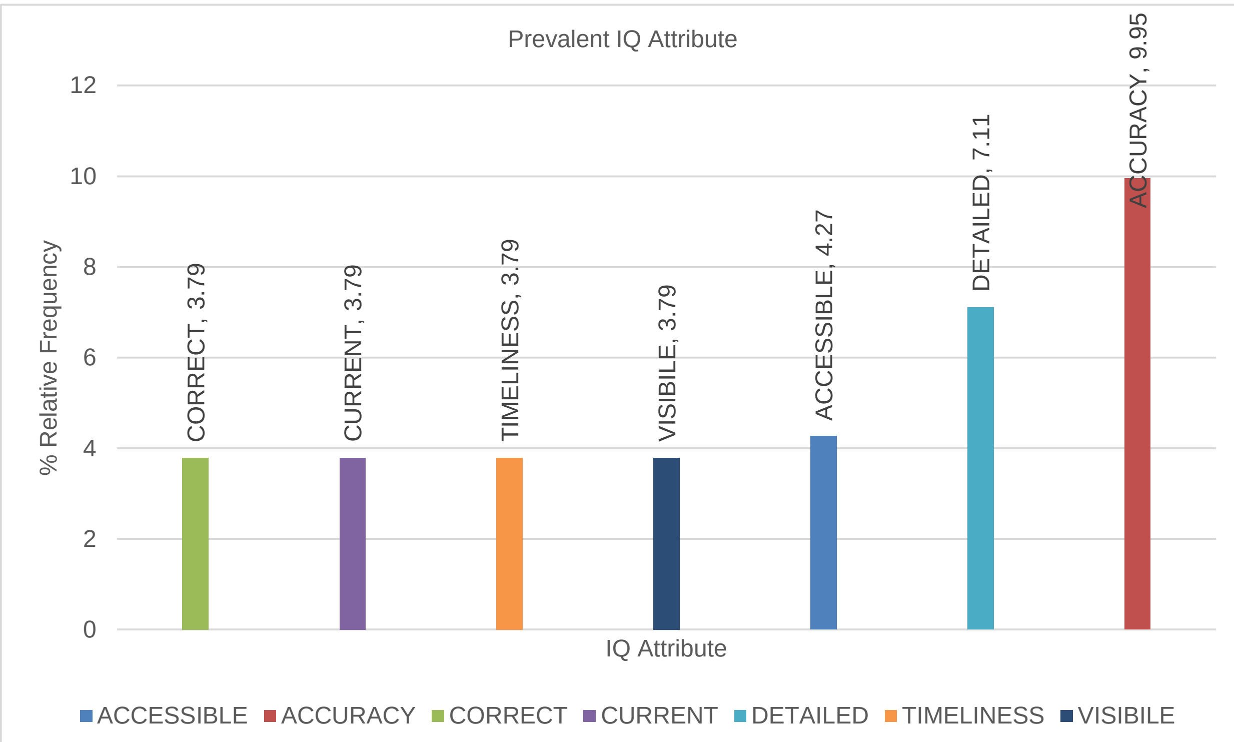


Figure 4:7 Frequency of Occurrence of IQ Attributes

4.3 Chapter Summary

This chapter represents the achievement of research objective two as stated in chapter 1, which set out to examine what factors influenced asset management information quality in facilities management. This phase of the study utilises non-probability sampling[15]. The samples were selected to serve an investigative purpose rather than to be statistically representative of a population which has been acknowledged as useful for a concentrated investigation of a small population or in an exploratory study (Carter & Little, 2007; Schutt, 2012)

Based on this argument, data was collected from organisations engaged in AM within the field of FM to examine what factors influenced asset information quality in facilities management. Nine respondents agreed to take part in the research, and relevant data was collected on-site via a semi-structured interview. The entire interview session lasted between 30 – 60 minutes for each participant. A participant coding scheme was developed to facilitate the analysis of the responses of the participants and ensure anonymity was fully established. A thematic analysis of the data was performed, and this was classified into three domains based on the conceptual framework developed:

1. The information domain
2. The organisation domain
3. The people domain

Based on this classification, several themes, which included subthemes, were identified which reflects the opinions of the respondents in relation to the questions being asked. These have been represented in Figure 4:8. It can be observed that under the information domain, the theme Barrier to Quality Asset Information had the highest number of references (34.55%) made concerning this issue (Appendix III). This was seconded by Information Systems Configuration with 28.18% references made. Under

[15] In qualitative studies, non-probability sampling methods are the dominant sampling method used for selecting the appropriate sample elements for the research (Bryman, 2008; Saunders et al., 2012; Schutt, 2012) (see chapter 3)

the organisation domain (Appendix IV), the theme Organisational Processes had the highest number of references made to it (50.67%). This was followed by AM Processes with 26.67% references. In the people domain, Development and Behaviour themes had very close values of 41.67% and 37.50% respectively (Appendix V). In essence, the magnitude of these values seems to suggest the level of concerns associated with factors influencing IQ as expressed by the participants undertaking AM programs in facilities management. To the end, further investigation into these issues will, therefore, need to be explored to ascertain the impact on issues such as performance, cost, risk, and quality of service.

This phase also sought to determine the attributes of IQ associated with AM programs in FM organisations. It was observed that there was a proliferation of IQ attributes within the environment. This complicated the ability to determine what attributes actors hold as important to their operations. However, this study was able to identify what attribute are regarded as important by actors interviewed within the organisations. This was determined using a frequency distribution of the identified attribute as mentioned by the respondents during the interview analysis. From this process, seven (7) IQ attributes was identified and noted to be the important attributes in assessing the quality of information. These include *accessible, accuracy, correct, current, detailed, timeliness,* and *visible.* The variables identified from the analysis conducted in this section have been fed into the quantitative analysis (phase 2) as indicated from the adopted methodology. These variables include the size and structure of the organisation and the information quality attributes. The rationale for these variables stems from the context of the domains being investigated. These domains i.e. information, organisational, and people operate within an organisational context. The organisational context is further influenced by the size of the organisation. As such, the larger the size of the organisation, the more elaborate its structure and the greater proliferation of information quality issues.

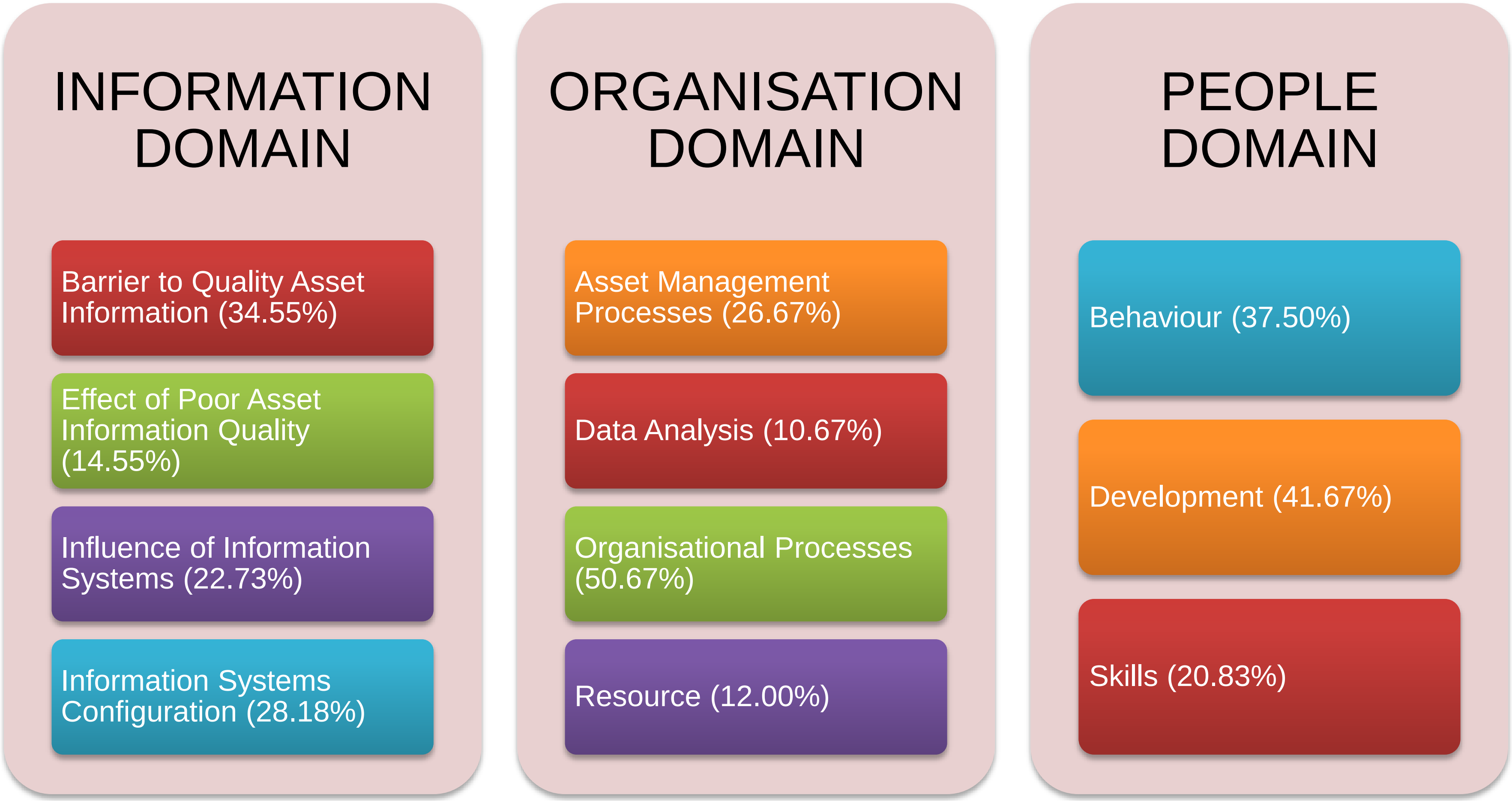


Figure 4:8 Thematic Analysis of Factors Influencing AM Information Quality

Chapter 5 Quantitative Data Analysis – Phase 2

This chapter presents the quantitative analysis for the second phase of the exploratory study. This seeks to achieve objective two of the research (see chapter 1). Evidence from the qualitative analysis and the literature suggest that information quality is perceived to be a prevailing issue in FM organisation (Jylhä & Suvanto, 2015).

In the field of facility management (FM), it has been argued that poor information quality aggravates the overload of work (Jylhä & Suvanto, 2015). Jylhä & Suvanto, (2015) further argues that actions based on poor information have a negative impact on the value creation process for the organisation. However, evidence from published research does not provide empirical evidence to the prevalence of information quality in FM. To this end, this section aims to provide empirical evidence of the prevalence of information quality issues in the FM industry within the context of AM. It provides an extensive analysis, using robust techniques that measure the prevalence of this issue. The variables used in the quantitative analysis are derived from the qualitative analysis in the first phase of the research. The next section of this chapter presents the questionnaire design uses in collecting the data used in the study.

5.1 Questionnaire Design

A questionnaire was developed based on specific identified variables from the qualitative phase of the research and literature review. The benefit of using the questionnaire within this phase of the research was to enable the collection of information in a standardised manner from a large sample that satisfies the criteria for analysis and permits the inference of results to the wider population (Rattray & Jones, 2007; Saunders et al., 2012). Rattray & Jones, (2007) posits that when interpreting results from questionnaires, the development process should be defined in sufficient detail and rigour.

The identified variables included within the questionnaire (

Table 5:1) was determined to be relevant to the study of information quality and of particular interest in AM programmes carried out by facilities management organisations. The variables were derived from the qualitative phase of the research (phase 1). These were the size and structure of the organisation, and the information quality attributes. As indicated from the preceding section, the rationale for these variables stems from the context of the domains being investigated i.e. information, organisational, and people operate within an organisational context. In light of this, the size of the organisation influences the organisational context by. As such, the larger the size of the organisation, the more elaborate its structure and the greater proliferation of information quality issues. This has facilitated the operationalisation of the research question and objectives (Rattray & Jones, 2007; Scheuren, 2004).

Detailed attention was paid to the design of the questionnaire as this has an effect on the reliability and validity of the collected data (Saunders et al., 2012). To satisfy the reliability and validity of the data collected, the questionnaire (see Appendix VIII), was further divided into three categories, which is discussed in sections 5.1.1 5.1.2 and 5.1.3 to enable the respondents fill out the questionnaire easily and guarantee high a response rate (Bovee, 2004). These choices were mutually exclusive to ensure a single answer does not fall into more than one category and exhaust the entire range of answers (Scheuren, 2004).

To collect the relevant data using the questionnaire, two types of data variables were applied: (1) opinion data variable, and (2) attribute data variable. Opinion data variable are continuous variables that record respondents' feelings about an issue, while attribute data variable are categorical variables that record data about respondents' characteristics such as age, gender, marital status, education, occupation, and income (Bartlett et al., 2001; Saunders et al., 2012).

Table 5:1 Questionnaire Variables

Category	Variable	Variable Type	Question Type
Demographic	Gender	Attribute (Categorical)	Open Ended Multiple Choice
	Age	Attribute (Categorical)	Close Ended Multiple Choice
	Educational Level	Attribute (Categorical)	Open Ended Multiple Choice
	Years of Experience	Attribute (Categorical)	Close Ended Multiple Choice
Organisation	Organisational Level	Attribute (Categorical)	Close Ended Multiple Choice
	Organisation Size	Attribute (Categorical)	Close Ended Multiple Choice
Information Quality	Information Quality Issue Prevalence	Opinion (Continuous)	Likert Scale
	Information quality attribute importance	Opinion (Continuous)	Likert Scale

5.1.1 Demographic Category

The demographic category of the questionnaire aimed at collecting information regarding the characteristics of the respondents to the questionnaire. A combination of open-ended multiple-choice questions and close-ended multiple-choice questions were used in this section. The variables of interests were (1) gender, (2) age, (3) educational level, and (4) years of experience. The aim of this category is to determine the distribution of respondents in the industry using descriptive analysis.

5.1.2 Organisation Category

The organisation category provided statistic relevant to the organisation characteristics of the respondents. The variables of interest were the (1) organisational level and (2) organisation size. These variables explored the attributes of the respondent through close-ended multiple-choice questions. The aim was to provide an understanding of the structure of the organisation and act as a precursor to the effect of organisation structure on the quality of information within AM programs undertaken by FM organisations.

5.1.3 Information Quality Category

The information quality category measured the opinions of information quality issue, and information quality attribute importance variables on an 11-point and 5-point Likert scale respectively. The aim was to provide empirical evidence on how organisation structure affects the quality of information and what dimensions of information quality were relevant to AM programs.

5.2 Sampling

This section discusses the sampling procedure used in this study. Being the case that it is impractical to obtain data from the entire population under consideration, appropriate sampling procedures needs to be carried out to ensure the sample chosen represents the population under consideration (Saunders et al., 2012). As an addendum to the impracticality of obtaining data from the entire population, Marshall, (1996) argues and adds that it is neither efficient nor ethical to study whole populations. The aim of sampling in quantitative studies is to draw a representative elements from the population so that generalisation can be made to the population based on the results obtained from the sample (Marshall, 1996). McClave & Sincich, (2000) summarises this as data selected from some larger set of data whose characteristics we wish to estimate.

The dominant approach to sampling in quantitative studies is the random (probability) sampling (Bryman, 2008; Saunders et al., 2012; Schutt, 2012; Teddlie & Yu, 2007). This approach ensures that every subset of fixed size in the population has an equal chance of being included in the sample (McClave & Sincich, 2000; Teddlie & Yu, 2007). As noted by Marshall, (1996) the size of the sample is determined by the optimum number necessary to enable valid inferences to be made about the population. Marshall, (1996) also suggests that a compromise needs to be made when selecting the appropriate sample size. According to Marshall, (1996) the larger the sample size, the smaller the chance of a random sampling error, but there is little to be gained from studying very large samples because the sampling error is inversely proportional to the square root of the sample size. Therefore, the optimum sample size depends upon the parameters of the phenomenon under study i.e. information quality and the analytical techniques applied in the study (Marshall, 1996).

For random sampling to be successful, the characteristics of the population being studied should be known (Marshall, 1996). As such, the population being studied in this research are members of organisations within the facilities management industry. To ensure that the selected sample reflects the population being studied and inference can be made, a systematic approach to sampling was instituted. The sampling procedure for this phase of the study entailed the following steps: (1) determining the sampling frame, (2) selecting the appropriate sample size, (3) selecting the appropriate sampling technique, and (4) determining the mode of distribution and response rate. These are discussed in the following subsections.

5.2.1 Sample Frame

The design of this research requires the understanding and consideration of the unique characteristics of the specific research participants (Devers & Frankel, 2000). These unique characteristics are contained within the sample units, which represents a member of the population, used in the research to understand the context being explored (USEPA, 2002). As such, the selection of the target population containing the sample units for the research study should correlate with the purpose of the study (Chen, Effler, & Roche, 2001). To this end, an important demand in this research concerns the source and origin of the sample, which presents an utmost priority for the researcher.

A key issue in choosing the sample relates to whether the members chosen are representative of the population (Burgess, 2001). Hence, obtaining a comprehensive list of the target population to draw a representative sample is one of the main requirements for the sampling technique used in this study (Hua et al., 2005). This comprehensive list is known as the sampling frame. The sampling frame represents a list of all the possible sampling units in the population from which the sample can be selected (Saunders et al., 2012; USEPA, 2002). It specifies the criteria for identifying, selecting, and securing participants capable of answering the research question (Devers & Frankel, 2000). The utility of the sample frame used in this research depended on the quality condition of information provided within it. The condition of such information provided by the sample frame met the criteria of being current, complete, accurate, and representative of the population being surveyed (Chen et al., 2001; Saunders et al., 2012). Also Chen et al., (2001) went further to indicate that the target population within the sampling frame from which the potential research participants are selected should be comprehensive. From this, it is possible to perform an effective probability sampling to select at random the required sample needed for the research (Burgess, 2001).

It must be noted however that the reliance on the sampling frame should be considered with caution in research as this may inadvertently introduce some level of bias into the selection of the desired sample used for the research (Chen et al., 2001; Murphy, 2002; Wilson & Elliot, 1987). An unreliable sampling frame, therefore, reduces the representativeness of the sample and creates serious damage to the validity of the survey results (Chen et al., 2001). For instance, the underreporting of a particular group (Wilson & Elliot, 1987) or the preference of a source to list particular groups due to type of activity (Murphy, 2002) has the potential to represents the sample falsely.

To this end, careful efforts was invested to ensure the sample frame used in this study met the conditions of being current, complete, accurate, representative, and comprehensive in order to reduce the level of bias that may be introduced in the data reporting (Chen et al., 2001; Murphy, 2002; Saunders et al., 2012; Wilson & Elliot, 1987). The sample frame used for this study was obtained from the Fame database containing detailed information on UK and Irish companies (BvD Fame, 2013). Fame was chosen because it provided a comprehensive database of companies' information and business intelligence by combing information from more than 140 sources covering close to 180 million companies for individual countries, regions, and the world (BvD Fame, 2013). An extensive coverage of private companies including relevant internet contact, detailed company hierarchies, and standardised financial reports have been provided for detailed analysis (BvD Fame, 2013). The specific search criteria used in identifying the companies to draw the sample from was based on the following search criteria: "UK SIC[16] (2007): All codes: 81100 - Combined facilities support activities". 6,960 results in total were returned based on this search. This was exported to a spreadsheet application (Microsoft Excel) for detailed analysis of the companies from which the appropriate sample size was determined (discussed in the next section).

5.2.2 Sample Size

The next step of the research involved the determination of the appropriate sample size from the selected population (6,960) in the sample frame that enabled the ability to generalise findings back to the population. It must be noted here that the sample size of a study can influence the detection of significant differences, relationships, or interactions amongst elements of a population (Bartlett et al., 2001). According to Bartlett et al., (2001) inappropriate, inadequate, or excessive sample sizes influences the quality and accuracy of research results.

Several methods for sample size determination have been suggested by several authors (Bartlett et al., 2001; Krejcie & Morgan, 1970; McClave & Sincich, 2000; Saunders et al., 2012). These methods involve the use empirical techniques to estimate the optimal sample size to be studied. A significant consideration is the acceptable margin of error that can be tolerated within the study. These errors include alpha errors and beta errors (Bartlett et al., 2001). Alpha errors refer to a situation that results in finding a difference that does not actually exist in the population, while beta error results in failing to find a difference that actually exist in the population (Bartlett et al., 2001). Effective sampling takes into consideration these errors and non-response bias and tries to minimise them accordingly (Bartlett et al., 2001; Krejcie & Morgan, 1970). The margin of error used in this research specifies the degree of accuracy of the results obtained from the sample and asserts a probability that the result from the sample

[16] SIC: Standard Industrial Classification

approximates the number that would be derived if the whole population is queried (McClave & Sincich, 2000). Thus using an adequate sample will result in more reliable, valid, and generalizable results (Bartlett et al., 2001).

This study uses the formula provided by Krejcie & Morgan, (1970) in calculating the appropriate sample size to be used (Equation 5:1).

$$s = \frac{X^2\, NP(1-P)}{d^2(N-1) + X^2 P(1-P)}$$

Equation 5:1 Sample Size (Krejcie & Morgan, 1970)

Where:

- X^2 = the table value of chi-square for 1 degree of freedom at the desired confidence level (95%)
- N = the population size (determined from the sample frame)
- P = the population proportion (assumed to be .50 (50%) of the population)
- d = margin of error - the degree of accuracy at 95% confidence level
- s = required sample size

Based on this method, the calculated sample size used for this study was 363, and the result of this calculation is presented in (Table 5:2) by means of substitution.

Table 5:2 Determined Sample Size Based On the Selected Population

X^2	N	P	d	s
3.841	6,690	0.5	0.05	363

5.2.3 Sample Technique

The approach to sampling used in this phase of the research was probability-based (see chapter 3) which refers to a method of selecting samples such that the probability of being included in the sample is known for every unit in the sampling frame (USEPA, 2002). Probability sampling is based on underlying theoretical distributions of observations, or sampling distributions (Teddlie & Yu, 2007). Though several sampling techniques have been identified and used in probability sampling, this phase of the research has adopted the simple random sampling technique (Saunders et al., 2012; Teddlie & Yu, 2007; USEPA, 2000, 2002).

Simple random sampling involves selecting samples at random from the sampling frame using a random number algorithm where which each unit in the accessible population is assigned a random number and has an equal chance of being included in the sample (Saunders et al., 2012; Teddlie & Yu, 2007). The use of random numbers allow the sample to be selected without bias thereby ensuring the sample is representative of the population (Saunders et al., 2012). By using this approach, the probability of a unit being selected is not affected by the selection of other units from the accessible population (Teddlie & Yu, 2007). However, caution needs to be considered when using this approach as this may lead to parts of the population being over or under represented (Saunders et al., 2012, p. 274). The primary benefit of simple random sampling is that it protects against selection bias by guaranteeing selection of a sample that is representative of the sampling frame, provided that the sample size is not extremely small (USEPA, 2002).

5.2.4 Distribution and Response Rate

The response rate refers to the proportion of people from the sample who have responded to the questionnaire or from which data is to be collected (Saunders et al., 2012). According to Bartlett et al., (2001) determining the response rate is not a precise science as several factors have an influencing effect on its outcome. For instance, Saunders et al., (2012) noted that the mode of distribution of the questionnaire has an effect on the response rate and urges against unsubstantiated claims of comparison with other survey response rate. Be that as it may, there is the need to obtain a high response rate to reduce the risk of non-response bias and ensure the sample is representative (Saunders et al., 2012). This can be achieved by oversampling methods prescribed by Bartlett et al., (2001), but was not used in this study.

With specific reference to Saunders et al., *op. cit.* the questionnaire used for this phase of the research was administered via the internet whereby a link was provided to the respondent to access the questionnaire. This has been described as a self-completed internet-mediated questionnaire (Saunders et al., 2012; Scheuren, 2004). This mode of questionnaire distribution was consistent with studies concerning information quality (Slone, 2006). According to Bovee, (2004) and Saunders et al., (2012) self-completed internet-mediated questionnaire typically have a low response rate of about 11%. However, Burgess, (2001) indicated that it is quite common for survey response rates to be around 20%. Such low response rates are typically offset by a low distortion of respondents answer, due to the method of distribution, which affects the reliability of the data collected (Bovee, 2004; Saunders et al., 2012).

The mode of questionnaire distribution was deemed relevant to the research as it enabled the researcher reach difficult-to-access groups, ensured respondents remained anonymised, limited the ability of respondents to modify the questionnaire, and provided instant statistical results that could be viewed by the respondents (Bovee, 2004; Saunders et al., 2012). Data was collected data between February 2014 and August 2015 from targeted organisation involved in FM derived from the sample frame i.e. FM/AM companies, FM/AM software vendors, and FM/AM Clients. The response rate for this research was calculated based on the formula (Equation 5:2).

$$TR = \frac{Tr}{s - Ir} \, x \, 100$$

Equation 5:2 Response Rate (Saunders et al., 2012)

Where:

- s = Sample
- Tr = Total Responses
- Ir = Invalid Responses
- Vr = Valid Responses
- TR = Total Response Rate

Contrary to the view of reported low response rates from internet-mediated questionnaire, the administration of the questionnaire used for this research achieved a response rate of 42.22%, which is average for research conducted in the facilities management and affiliated industry (Table 5:3).

Table 5:3 Calculated Response Rate

Sample (*s*)	Total Responses (*Tr*)	Invalid Responses (*Ir*)	Valid Responses (*Vr*)	Total Response rate (*TR*)
363	150	8	142	42.22%

5.2.5 Pre-Analysis Check – Assessing Validity and Reliability of the Questionnaire

Central to the understanding of results derived from questionnaires are the issues of reliability and validity which underpin questionnaire development (Rattray & Jones, 2007). The validity, reliability, and response rate depends on the design of the questionnaire i.e. the design of the questions, the structure of the questionnaire, and the rigour of the pilot testing (Saunders et al., 2012). As indicated in the previous section, the design of the questionnaire has an effect on the validity and reliability of the data collected by the questionnaire. Saunders et al., (2012) noted that a valid questionnaire would ensure that accurate data that measures the concepts would be collected, while a reliable questionnaire ensure data are collected consistently.

The following methods were used in determining the validity and reliability of the questionnaire applied in the research respectively: content validity and internal consistency (Cronbach's alpha) (J. Pallant, 2013). Content validity refers to the extent to which the measurement device i.e. the questions in the questionnaire, provides adequate coverage of the questions investigated. As recommended by Saunders et al., (2012), to ensure the content of the questionnaire was relevant to the research, a pilot test was used to assess and refine the quality of the questionnaire by soliciting opinions from expert in the field facilities management (Saunders et al., 2012). The internal consistency was achieved using the Cronbach's alpha statistic to measure the consistency of responses across the groups of questions in the questionnaire (J. Pallant, 2013). Values for this statistic range between 0 and 1 with 0.7 being the recommended minimum level (J. Pallant, 2013). The scale measuring facets of information quality had a good internal consistency, with a Cronbach's alpha coefficient of .974. All data analysis was performed using SPSS ver. 22 for Windows. The following sections presents the data analysis obtained from the questionnaire. Section 2 presents the demographic data analysis; section 3 presents the organisational data analysis. Finally, section 4 presents the information quality analysis.

5.3 Demographic Data Analysis

Pallant, (2013) indicated that it is necessary to collect information from participants or respondents prior to exposing them to some experimental manipulation. This involves the collection and analysis of demographic information about the participants of the study. To this end, the first section of the questionnaire dealt with the demographic information of the respondent. The aim was to provide a better understanding of the characteristics of the industry and organisation by collecting general information about gender, age, educational qualification, and years of experience. Further to this, the effect facilities management organisations have on information quality within the context of AM programs was explored.

The perception of the facilities management industry has been characterised by stereotypes that indicates a predominance of male and technically oriented personnel (Asset Skills, 2010; BIFM, 2015; Sullivan, Georgoulis, & Lines, 2010). This presents a significant challenge to the industry and lies in the lack of empirical data which presents a detailed view of the facilities management industry (Sullivan et al., 2010). Sullivan et al., (2010) also reported that the facilities management professional is perceived to have (1) a level of education equivalent to that of the college level, (2) a workforce with an average age of 50 years, and (3) a workforce with an average of 10 years work experience. Despite this assertions from Sullivan et al., (2010), BIFM, (2015) posits that these stereotype no longer rings true.

As indicated by Sullivan et al., (2010), it is imperative to collect empirical information about the demographic nature of the facilities management industry. These provide statistical profiles of the characteristics and composition of the adult working population

(Kreitner & Kinicki, 2004). Mirrielees, (2006) acknowledged that the demographics of the workplace have changed over the years, with the growth of the knowledge worker gaining force in numbers and influence. As such the collection of such demographic data aid managers in determining the appropriate skills set to meet the required demand of labour (Kreitner & Kinicki, 2004).

The demographic characteristics of the facilities management industry have been determined in this study using descriptive analysis, which utilises numerical frequencies. Graphical methods to look for patterns in a categorical data set have been used to reveal the characteristics of the population as well. This also facilitates the ability to summarise the information revealed in a data set, and to present the information in a convenient form (McClave & Sincich, 2000). The next sections present the analysis of the variables: gender, age, educational qualification, and years of experience.

5.3.1 Gender

This variable measured the distribution of gender, broadly aligned on the male-female spectrum, within the facilities management industry. Though other gender categories that do not conform with this category are beginning to emerge (Gates & Scholar, 2011), these have not become mainstream in organisation research. However, the option to categorise ones gender other than that of the mainstream view was provided in the questionnaire (see Appendix VIII).

Asset Skills, (2010) and Sullivan et al., (2010) presents a view that the number of male employees within the facilities management industry outnumbers the number of female employees. On the contrary, BIFM, (2015), asserts a near 50/50 split between these groups. Evidence from the survey carried out in this research showed that 59.2% of the respondents were male, while 40.8% were female (Table 5:4 and Figure 5:1). Though the difference between the male and female groups were marginally small (18.4%) which supports the view of (BIFM, 2015), it still indicates a predominance of male group over the female group in the industry which supports the arguments put forward by Asset Skills, (2010) and Sullivan et al., (2010).

Table 5:4 Gender Distribution of Sample (n = 142)

Gender	Frequency	Percent (%)	Valid Percent (%)	Cumulative Percent (%)
Male	84	59.2	59.2	59.2
Female	58	40.8	40.8	100.0
Total Sample	142	100.0	100.0	

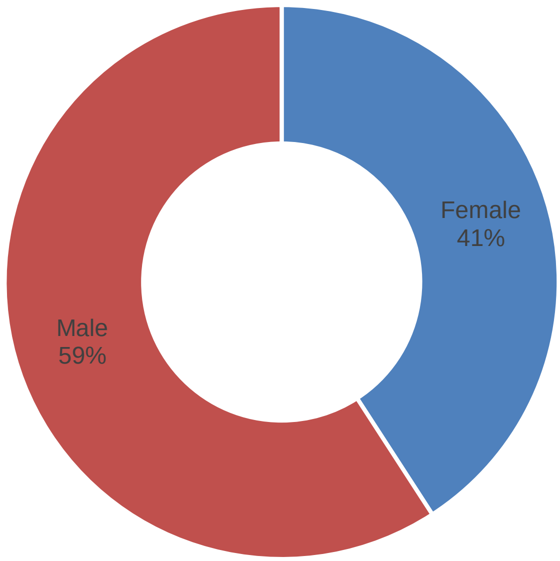


Figure 5:1 Gender Distribution of Sample (n = 142)

5.3.2 Age Distribution

Age distribution presents an important factor in the workforce of organisation. This is particularly associated with the level of skill or experience an individual may exhibit in a particular role (Kreitner & Kinicki, 2004). According to Kreitner & Kinicki, (2004), older workforce tend to have the most experience in an organisation. This, however, presents a challenge to facilities management as this group of people are likely to go into retirement thereby impeding the transfer of relevant skill to the younger workforce (BIFM, 2015). For instance BIFM, (2015) reports on the shortage of skills on the technical aspect of FM faced by many organisations as the age demographic shifts from old to young. This view has also been reported in Sullivan et al., (2010).

Asset Skills, (2010) reports that the predominant age profile of facilities management industry range between the ages of 24 and 54 years. BIFM, (2015) provides a narrower bracket of the main age group within the field of facilities management. According to BIFM, (2015), this age group falls between 25 and 35 age bracket. Evidence from this study showed that the approximately 30% of the sample fall between the age bracket of 26-30 years (Table 5:5 and Figure 5:2). It was also observed that the age groups of 36-40 and 41-45 years had percentages of 16.9% and 16.2% respectively which constitutes a relevant portion of the age distribution.

Table 5:5 Age Group Distribution (n = 142)

Age Group	Frequency	Percent (%)	Valid Percent (%)	Cumulative Percent (%)
18-20	2	1.4	1.4	1.4
21-25	3	2.1	2.1	3.5
26-30	42	29.6	29.6	33.1
31-35	16	11.3	11.3	44.4
36-40	24	16.9	16.9	61.3
41-45	23	16.2	16.2	77.5
46-50	20	14.1	14.1	91.5
51-55	5	3.5	3.5	95.1
56-60	6	4.2	4.2	99.3
61 and above	1	.7	.75	100.0
Total	142	100.0	100.0	

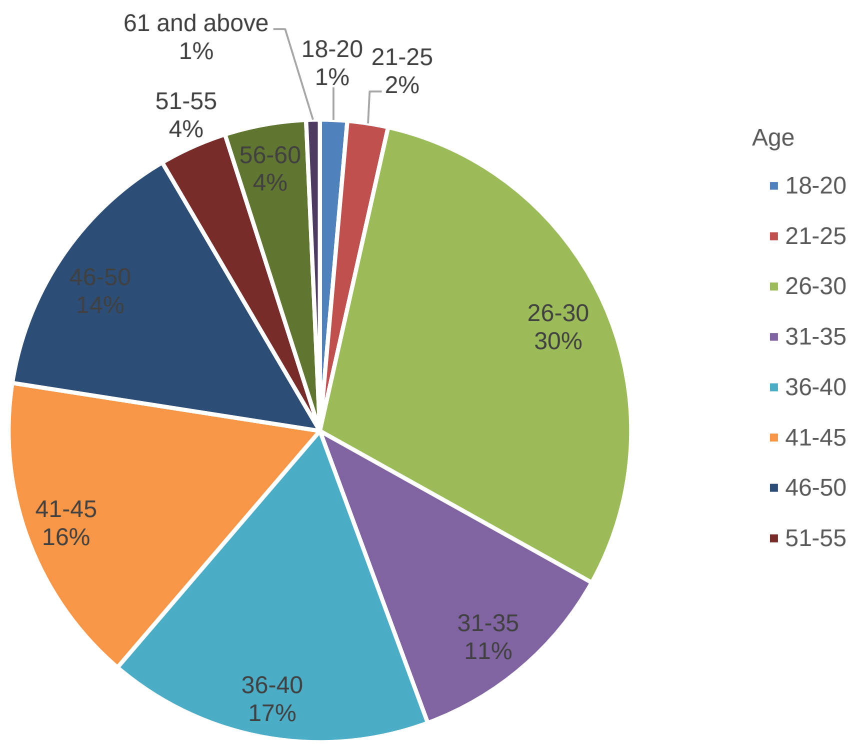


Figure 5:2 Age Group Distribution (n = 142)

5.3.3 Gender-Age Group Distribution

A further analysis was performed to determine the distribution of gender according the age group. From the analysis of categorising gender by age group, it was observed that majority of the male respondent (21.83%) from the sample fell within the age group of 26-30 years of age within a 95% confidence level. Majority of women (9.86%) from the sample fell within the 36-40 year group within a 95% confidence level (Table 5:6 and Figure 5:3). There was a predominance of men within the older age group as seen from the analysis which may indicate a situation where there may be more technically oriented.

Table 5:6 Gender-Age Group Distribution (n = 142)

Age Group	Gender		Total
	Female	Male	
18-20	0.00%	1.41%	1.41%
21-25	0.00%	2.11%	2.11%
26-30	7.75%	21.83%	29.58%
31-35	5.63%	5.63%	11.27%
36-40	9.86%	7.04%	16.90%
41-45	9.15%	7.04%	16.20%
46-50	5.63%	8.45%	14.08%
51-55	2.11%	1.41%	3.52%
56-60	0.70%	3.52%	4.23%
61 and above	0.00%	0.70%	0.70%

This phenomenon presents a significant statistic within the facilities management industry and supports the assumption that the male gender predominates the industry by entering at an early stage in their career usually through actively seeking a career in FM or by the selection from their company (Asset Skills, 2010; BIFM, 2015; Sullivan et al., 2010). However, due to the changing nature of the facilities management industry to being more customer-centric, there is a reported increase in women entering the industry at a later age (BIFM, 2015). These women tend to come from other service industries having a client-facing role such as hospitality and airline (BIFM, 2014).

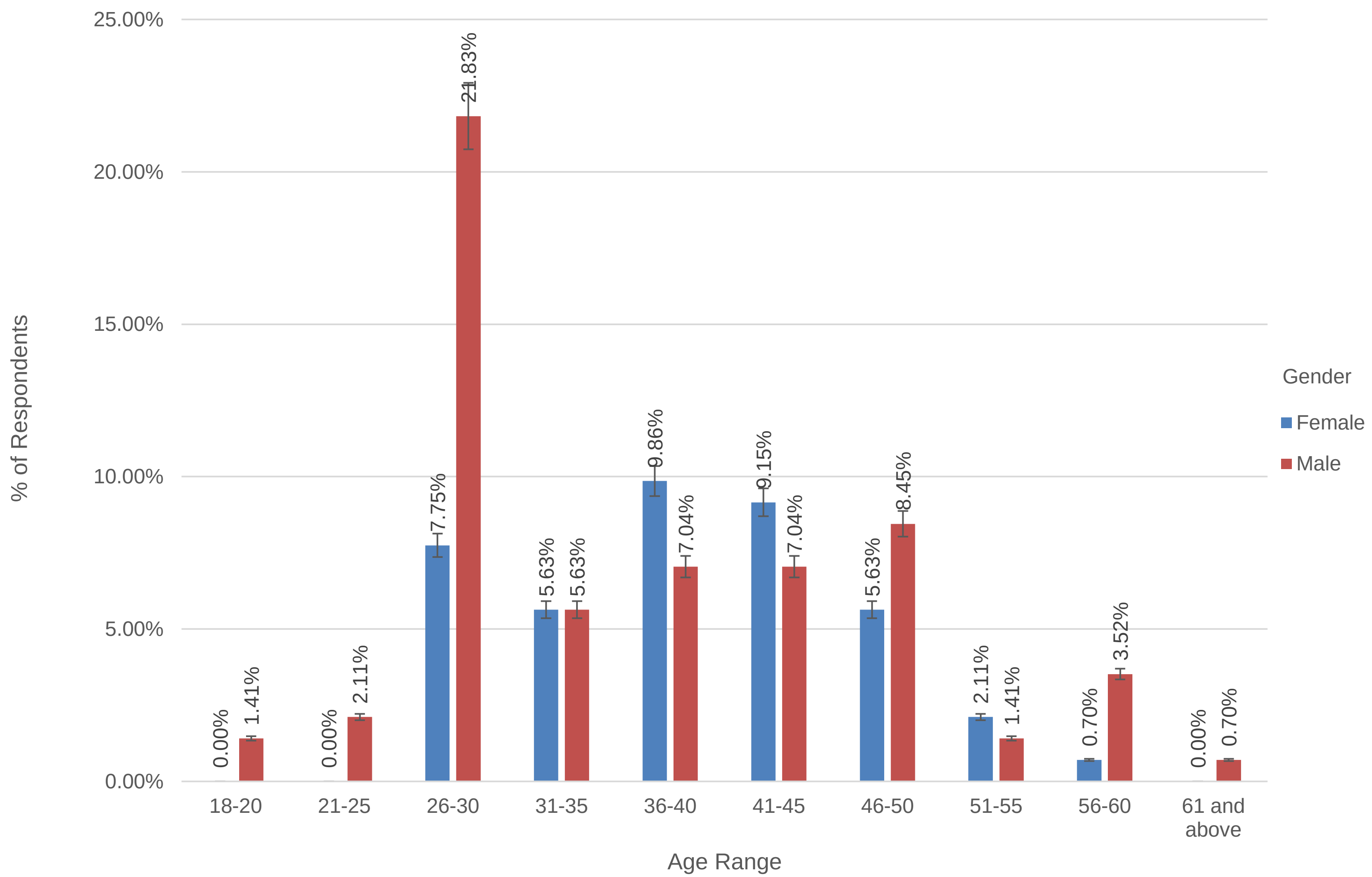


Figure 5:3 Gender-Age Group Distribution (n = 142, Confidence Level = 95%)

5.3.4 Educational Qualification

Education has been another vital aspect of effective FM. However, Sullivan et al., (2010) argues that the FM field is viewed as having an ill-defined career path, with very few FM academic programs to educate students, which hinders the influx of new talent entering the profession. Though the level of qualification held by individuals is widely used as proxy for skills and an indicator that allows comparisons over time (Asset Skills, 2010), very little importance is attached to the specific facilities management qualification (Asset Skills, 2010). Sullivan et al., (2010) stresses the limited number of formal academic programs that specifically educate students in FM as a contributory factor to the problem. This problem is exacerbated by a lack of a clear definition of the role of facilities management and an ever-widening sphere of undefined activities (Asset Skills, 2010; Yiu, 2008). This has led to a situation where FM is reliant on methods and practices from other disciplines to support its practices (Nutt & McLennan, 2002; Sullivan et al., 2010; Wearmouth et al., 2001)

Tay & Ooi, (2001) highlights the fact that many organisations do not regard FM as requiring professional management qualifications. However, evidence suggests that qualifications are becoming increasingly important for facilities management professionals, with employers more likely to demand qualifications alongside experience (Asset Skills, 2010; HAYS, 2010). Data from research conducted by BIFM, (2015), HAYS, (2010), and Sullivan et al., (2010) shows this explicitly. In order to ensure the growth of the FM discipline, Yiu, (2008) advocates for a unique knowledge base for FM while Tay & Ooi, (2001) proposes the development of specialist knowledge in managing the workplace to attain the required level of professionalism. These suggestions constitute the necessary qualifications that may be achieved by practitioners. The need for these qualifications in FM can be attributed to the growing demand for FM services in modern economy due to rising costs and sustainability challenges (BIFM, 2015). Bungar, (2012) presents signs where this is the case and highlights that FM organisations are engaging in the development of their workforce through innovative training strategies. HAYS, (2010) also indicated that another reason for pursuing further studies by FMs is the desire to develop career and skills. These qualifications encompasses NVQ[17], apprenticeships, degree based qualification, and professional bodies or institutes certifications (BIFM, 2015; HAYS, 2010).

The qualification assessed in this research were based on the prescribed regulated qualifications as set out by the United Kingdom Government (GOV.UK, 2016). Based on findings from this research, it was observed that 39.44% and 52.11% of the sample were educated to degree level, which constituted both a Level-6 and Level-7 qualification (GOV.UK, 2016) respectively (Table 5:7 and Figure 5:4). This supports the evidence provided by BIFM, (2015), HAYS, (2010), and Asset Skills, (2010) which indicates that there is a growing demand for attaining relevant qualifications in the facilities management field. As such, these individuals are able to make informed assessment of the effect of information quality on AM operations.

Table 5:7 Distribution of Respondent Educational Level (n = 142)

Academic Qualification	% of Respondents
Level-4:Certificate of higher education, HNC	1.41%
Level-5:Diploma of higher education, Diploma of further education, Foundation degree, HND	3.52%
Level-6:Bachelor's degree, Graduate certificate, Graduate diploma	39.44%
Level-7:Master's degree, Postgraduate certificate, Postgraduate diploma	52.11%
Level-8:Doctorate	3.52%
Grand Total	100.00%

[17] NVQ: these are National Vocational Qualifications (NVQs), which are work-based awards in England, Wales, and Northern Ireland. They are achieved through assessment and training. In Scotland they are known as Scottish Vocational Qualification (SVQ) (GOV.UK, 2016)

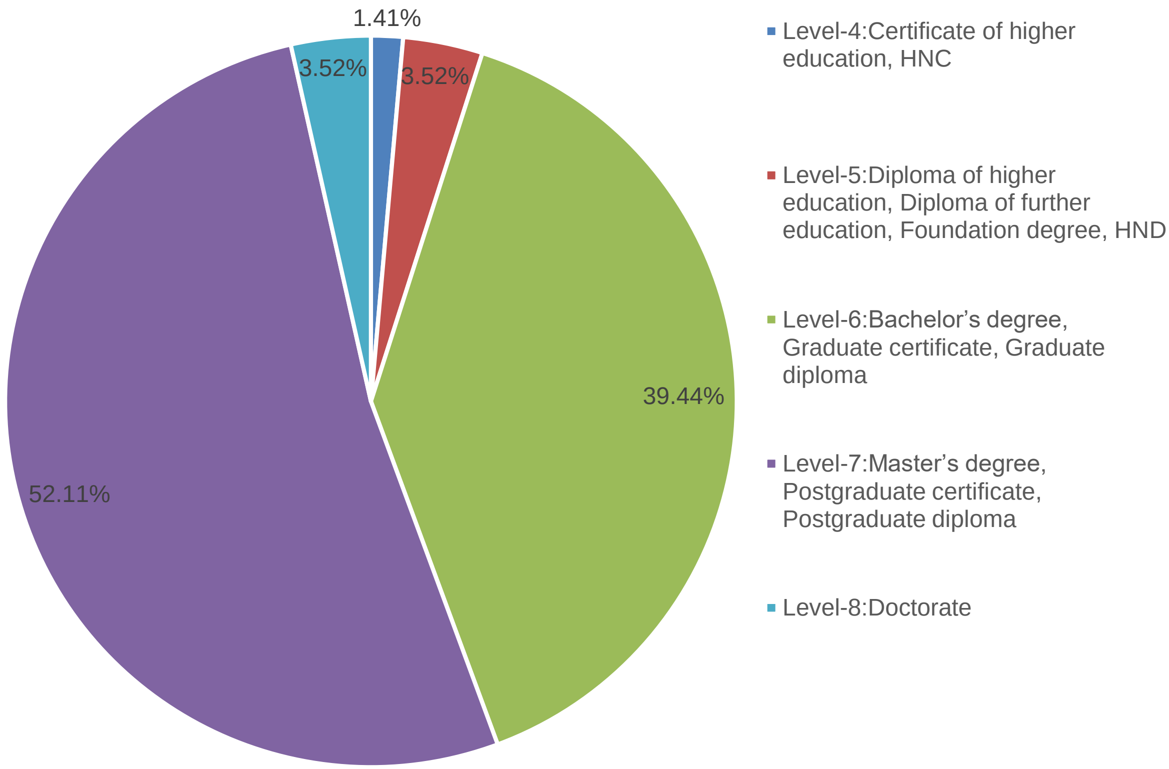


Figure 5:4 Distribution of Respondent Educational Level (n = 142)

5.3.5 Years of Experience

It was observed from the analysis that majority of those sampled had between 6 to 10 years of experience accounting for 52.8% of the sample size (Table 5:8 and Figure 5:5). This supports the evidence made by (BIFM, 2015) who indicates that more than 50% of their sample had in excess of 4 years' experience in FM. With regards to the effect on information quality, it is shown that there is consistency of judgement with years of experience (Das, Poh, & Chew, 2009). It is the case that the greater of years of experience an individual has in the workplace, the better his or her judgement concerning the quality of information.

Table 5:8 Years of Experience (n = 142)

Years of Experience	Frequency	Percent	Valid Percent	Cumulative Percent
0-1	6	4.2%	4.2%	4.2%
2-5	37	26.1%	26.1%	30.3%
6-10	75	52.8%	52.8%	83.1%
10 and above	24	16.9%	16.9%	100.0%
Total	142	100.0%	100.0%	

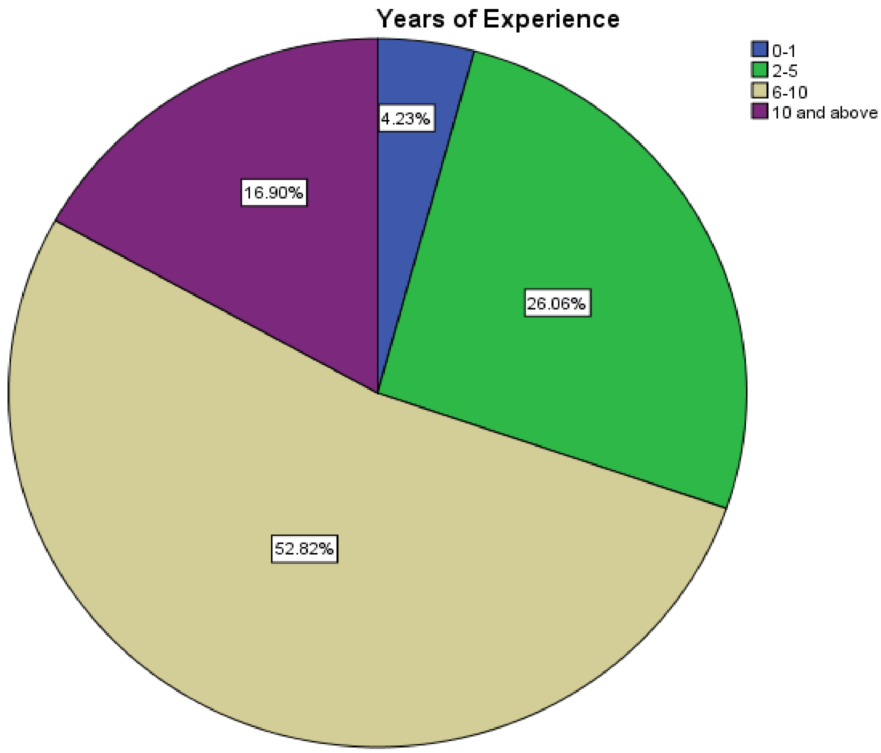


Figure 5:5 Years of Experience (n = 142)

5.3.6 Education and Years of Experience Distribution

The final analysis of the demographic data examines the distribution of level of education and years of experience in the FM. It can be observed that there was a preponderance of participants indicating long years of experience and high levels of qualifications. Majority of the questionnaire respondents indicating years of experience of 6-10 years had possessed an education qualification equivalent to the Level-7 (34%) at 95% confidence interval (Table 5:9 and Figure 5:6). This was followed by respondents in the Level-6 category with years of experience of 2-5 years (18%). However, this was closely marked with those having years of experience of 6-10 years (18%). This trend might be attributed to the fact that many professionals in the industry are actively seeking the necessary qualifications to enhance their careers and skills. On close examination of the chart, it can be seen the longer the years of experience, the higher the level of qualification received.

Table 5:9 Distribution of Respondent Educational Level Relative to Years of Experience (n = 142)

Academic Qualification	Years of Experience			
	0-1	2-5	6-10	10 and Above
Level-4:Certificate of higher education, HNC	1%	1%	0%	0%
Level-5:Diploma of higher education, Diploma of further education, Foundation degree, HND	0%	3%	1%	0%
Level-6:Bachelor’s degree, Graduate certificate, Graduate diploma	1%	19%	18%	1%
Level-7:Master’s degree, Postgraduate certificate, Postgraduate diploma	2%	3%	34%	13%
Level-8:Doctorate	0%	1%	1%	2%

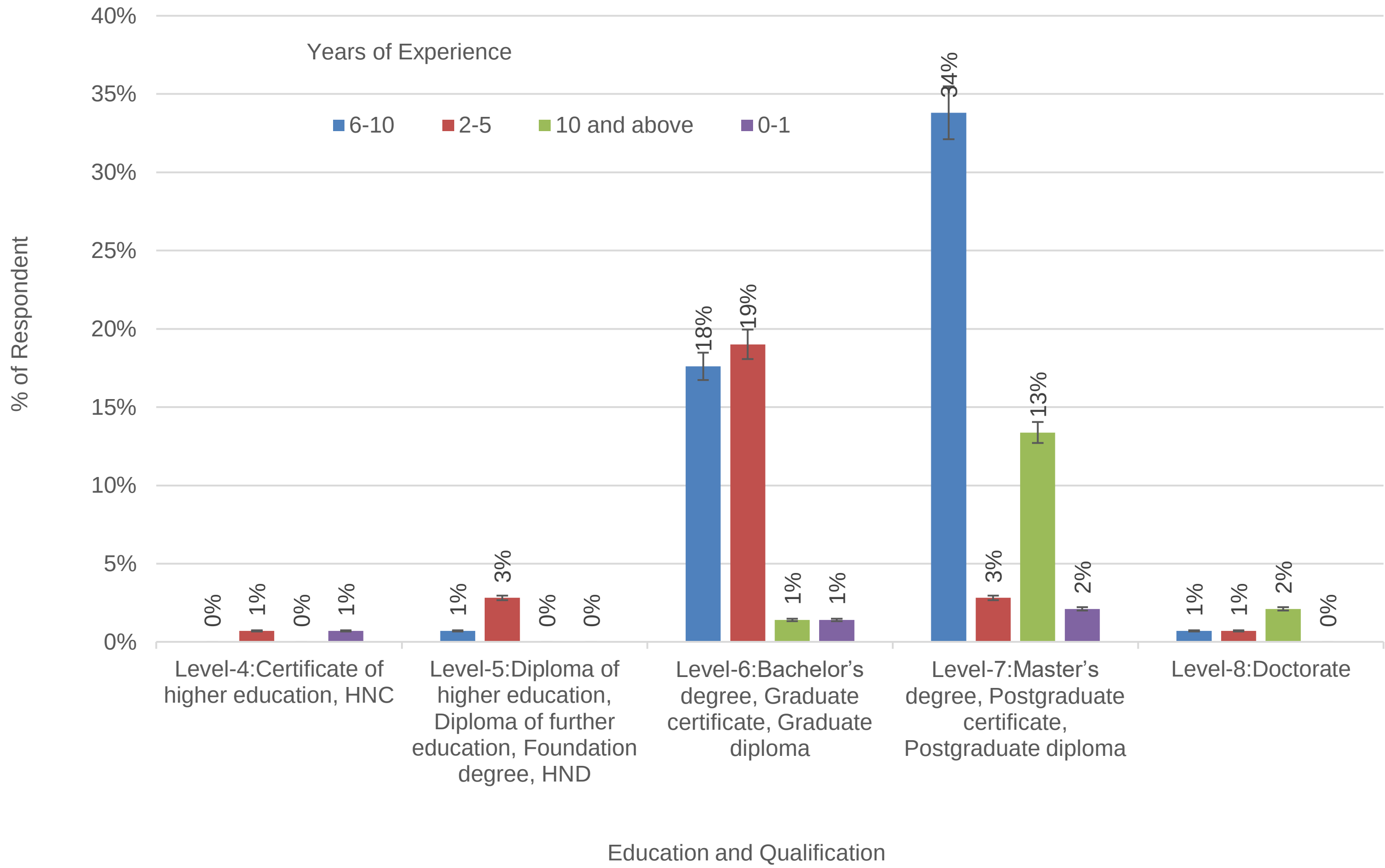


Figure 5:6 Distribution of Respondent Educational Level Relative to Years of Experience (n = 142, Confidence Level = 95%)

5.4 Organisation Data Analysis

It has been noted that several factors possess the ability to influence the position of FM functions such as business processes, structure of organisation, size of the organisation (Chotipanich, 2004). This, in turn, influences the quality of information within AM programs performed by such FM companies. In order to understand this phenomenon in detail, it is important to understand the make-up of organisation operating within the FM industry. This is presented within this section of which the essence is to put forward a descriptive analysis of the characteristic structure of the respondents organisations sampled in this research. The main statistic produced is a frequency distribution examining organisation size and organisation level (hierarchy).

Organisations have been defined as social arrangements for achieving controlled performance in pursuit of collective goals (Huczynski & Buchanan, 2000). According to Huczynski & Buchanan, (2000) organisations have a strong claim to the position of dominant institution in contemporary industrial and post-industrial society. To achieve this level of dominance, organisations are tasked with making necessary provisions for activities directed towards the achievement of stated goals (Huczynski & Buchanan, 2000). The configuration of these activities makes up the organisation structure and is a major determinant in shaping the extent to which the goals of the organisation are achieved (Sisk, 1977).

In his seminal work, Mintzberg, (1979) defines the structure of an organisation as the sum total of the ways in which it divides its labour into distinct tasks and then achieves coordination among them. Huczynski & Buchanan, (2000) adds to this and explains that organisation structure constitutes a system of arrangements and work patterns between the various positions and their holders. Kaya & Alexander, (2006) provides an alternative definition of organisation structure as a formal representation that gives clues about people, influencing lines, decision makers, terminologies, tasks integration, and synergies. Organisations constantly modify and refine the mechanism by which they achieve their purposes by rearranging their structure of roles and relationships and their managerial processes (Miles, Snow, Meyer, & Coleman, 1978). It further provides a pattern of interaction and coordination that links the technology, processes, and human components to ensure that the organisation accomplishes its purpose (Huczynski & Buchanan, 2000). These are influenced by specific factors as highlighted by Mintzberg, (1979). These factors have been applied in the context of facilities management to include:

1. Chain of command (hierarchy)[18]: the levels in an organisation structure referring to strategic, tactical, and operational level
2. Specialisation: the breakdown of jobs into narrow areas or work and responsibilities
3. Succession routes: the degree to which jobs are designed for the career progression within the organisation
4. Geographic dispersion: the number of geographical regions FM has responsibilities for
5. Reporting line: the line manager
6. Size: the relative size represented by the number of employees

Kaya & Alexander, (2006) argues that facilities management organisation are fundamentally different, while AMA Research Ltd, (2004) explicitly posits that FM providers vary in terms of organisation structure. The practice of FM, according to Kaya & Alexander, (2006), is organisation specific and can only reference its setting organisation because it operates differently in different settings. Within the context of this research, the chain of command (hierarchy) and size are the main variables of interest. The focus on these variables within the context of this research in no way diminishes or minimizes the importance of the other factors but lends its selection to the relevance of determining their[19] effect on the quality of information in AM programs within FM organisation (Grenn, 2014; Jylhä & Suvanto, 2015; Kaya & Alexander, 2006).

[18] In this study this is referred to as the organisation level
[19] Hierarchy and Size

5.4.1 Organisation Size and Level Analysis

Organisation size presents a significant factor in organisation dynamics and explains many of the characteristics of its level and structure (Allen & Stephenson, 1983; Mintzberg, 1979). According to Mintzberg, (1979) the larger the organisation, the more elaborate its structure and level, the more specialised its tasks, the more differentiated its units, and the more developed its administrative component. As size increases, organisation structure becomes more formal and complex (Sisk, 1977). So also does a more elaborate administrative hierarchy develop (Mintzberg, 1979). Mintzberg, (1979) further added that increased size gives greater homogeneity of work within units but greater diversity of work between units. This, in turn, has an adverse effect on the quality of information circulating within the organisation (Batini & Scannapieco, 2006). This view has been cited by Haug et al., (2013).

Since size have an influence on the levels within an organisation, it is, therefore, important to determine the criteria for setting out the appropriate size of an organisation. Several standards have been used in defining the size of an organisation, and this differ between countries (Beer, 1964; Caplow, 1957; European Union, 2003; FINK, 1998; Nottinghamshire County Council, 2013; Nwankwo, Owusu-frimpong, & Ekwulugo, 2004). Caplow, (1957) distinguishes between organisation size as small, medium, large and giant groups. FINK, (1998) noted that organisations are usually identified by the number of people employed. This has further been categorised into small and medium organisations having fewer than 500 employees and large organisations considered to have over 500 employees (FINK, 1998). FINK, (1998) also regarded very small firms as micro businesses. Beer, (1964) uses a geographical construct in determining the size of an organisation and defines this as the number of employees at any given geographical location. The limitation to this definition is that it does not take into consideration multi-national organisations who have branches or subsidiaries in other geographical locations. Nwankwo et al., (2004) explicitly classify organisations in terms of the number of people employed. According to Nwankwo et al., (2004) organisations with less than 100 employees are considered small, those employing between 100 and 500 workers were considered medium-sized, and those with above 500 employees were considered large. For the European Union, (2003) the main determinants of the size of an organisation is defined by number of employees, annual turnover, and balance sheet. By the inclusion of the balance sheet, it takes into consideration subsidiaries and other geographical location of an organisation (Black, 2005) in contrast to the definition by Beer, (1964). To this end, the criteria adopted by the European Union, (2003) in defining an organisation is presented in Table 5:10.

Table 5:10 The European Union, (2003) Criteria in Defining an Organisation Size

Company category	Employees	Turnover	Balance Sheet Total
Medium-sized	< 250	≤ €50 m	≤ €43 m
Small	< 50	≤ €10 m	≤ €10 m
Micro	< 10	≤ €2 m	≤ €2 m

Nottinghamshire County Council, (2013) extends the definition of the European Union, (2003) and includes the criteria for large organisations and defines this as an enterprise which either employs more than 250 persons or which has either an annual turnover exceeding 50 million Euro and or an annual balance sheet total exceeding 43 million Euro.

Albeit no one-size-fits-all solution to the size of the organisation exist, for simplicity, only the number of persons employed in the organisation is used as the criterion for organisation size in this research (Table 5:11). Within the context of this research, size refers to the number of people within the organisation (Sisk, 1977) whereby the criterion of staff numbers remains undoubtedly one of the most important and the main criterion for size determination (European Union, 2003).

Table 5:11 Criteria for Organisation Size Adopted for the Research

Company Category	Employees
Large	>250
Medium	≤250
Small	≤ 50
Micro	≤ 10

Asset Skills, (2010) argues that FM companies are typically small in size employing ten or fewer staff. In striking contrast to this BIFM, (2014) reports of organisations engaged in FM having staff levels in excess of 1000 employees thus indicating very large organisations. This shows that organisations within the FM industry are diversified in terms of size; ranging from small, medium, and to large (Nwankwo et al., 2004). Evidence from this research presents a similar picture indicating that FM organisation range from small to large organisations (Table 5:12 and Figure 5:7).

Table 5:12 Organisation Size (n = 142)

Standard Attributes	Label	Value Size of Organisation	Count	Percent
Sample = 142	1 – Micro	0 - 10	4	2.8%
	2 – Small	11 - 50	23	16.2%
	3 – Medium	51 - 250	75	52.8%
	4 – Large	251 and above	40	28.2%

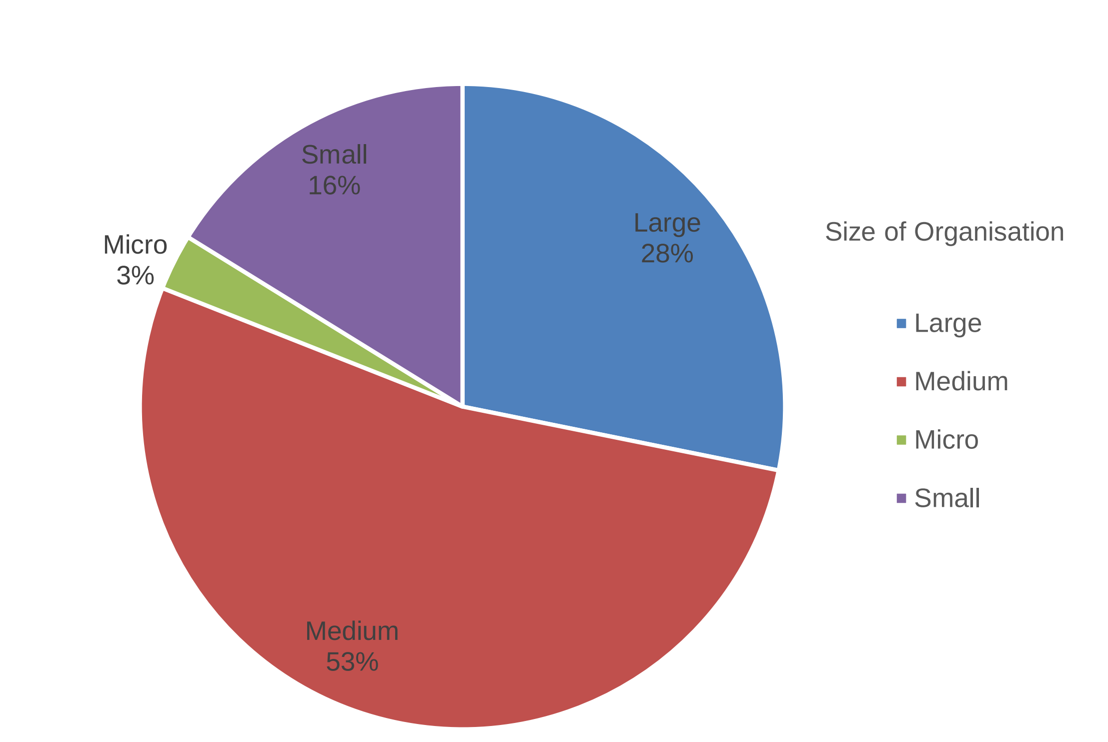


Figure 5:7 Organization Size (n = 142)

It was observed that majority of the respondents, 53%, originated from medium size firms employing between 51-250 people. This was followed by large organisation, >250, with 28% of the respondents. This observation may be due to the fact that most organisation engaged in FM are medium sized organisation or are organisations that have a predominance of FM roles (BIFM, 2014). In contrast to this, only 2.8% of the respondents indicated that they belong to micro organisation employing less than 10 employee. It is worth noting that most micro organisations are run as sole proprietorships or partnerships where the owner are registered as self-employed (Black, 2005).

The size of the organisation has consequences, directly or indirectly, for the quality of information within organisations. For instance, organisation size modifies the organisation structure in the following ways: more organisational levels; increased job differentiation; longer lines of communications; an increased span of control at both management and operative levels; and, more automation (Beer, 1964). When a firm is small, the way it is structured does not have a significant effect on the quality of information, but this changes dramatically as the organisation grows (WILLMER, 1977). Also, Caplow, (1957) highlighted a positive correlation between increase in organisation size and proportion of resources devoted to self-maintenance, the uniformity of organisational design, and the incidence of communication problems. Caplow, (1957) concluded that size has an effect on efficiency of task performance. Corroborating this claim, Beer, (1964) reported, with a statistically significant relationship of Chi-Squared tests at the .01 level and above, that the percentage the organisation devotes to administration increases with the size of the organisation. Thus, organisations with a large portfolio may have trouble collecting and maintaining a broad range of data and may suffer from information quality problems (Phelps, 2010).

AM actions within FM organisations occurs on several levels (Steenhuizen et al., 2014). These levels are categorised as strategic, tactical, and operational and have been used in assessing the quality of information within an organisation (Batini & Scannapieco, 2006; El-Akruti & Dwight, 2013; Redman, 1998). Also, these levels have been associated with the structure of the organisation[20] by Mintzberg, (1979) where he describes this as the strategic apex, the middle line, and the operating core (Figure 5:8).

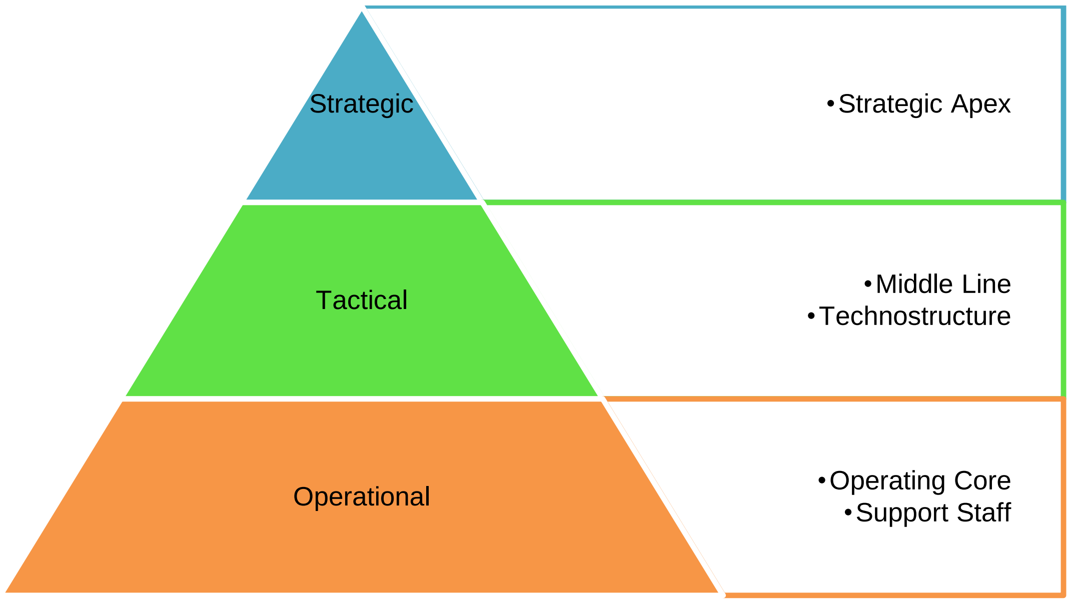


Figure 5:8 Levels of the Organisation Adapted From Mintzberg, (1979) Showing the Dominant Sphere of Influence

Within the industry, the role of FM is predominantly perceived to occur at the operational level based on the type of services it provides to organisations i.e. maintenance or cleaning (Asset Skills, 2010; BIFM, 2014; Bungar, 2012). However, there have been debates that FM should have a more strategic influence on the organisation is services (Cairns & Cairns, 2000; Katchamart, 2013; Steenhuizen et al., 2014).

The development of or maturity to the strategic level requires a growth of the organisation (Jensen, 2008). Such growth is therefore inextricably linked with the size of the organisation. As such, the notion of level within the FM industry should, therefore, reflect the number of staff operating at each of these levels. The result of the analysis shows a large concentration of the sample, 54.23%, operating within the tactical level

[20] This is elaborated in section 5.4.2

of the organisation (**Table 5:13**Table 5:13 and Figure 5:9). Only 13.38% of the sample identified as working on the operational level, while 32.39% on the strategic level.

Table 5:13 Distribution of respondent level in organization (n = 142)

Organisational Level	% of Respondent
Strategic	32.39%
Tactical	54.23%
Operational	13.38%

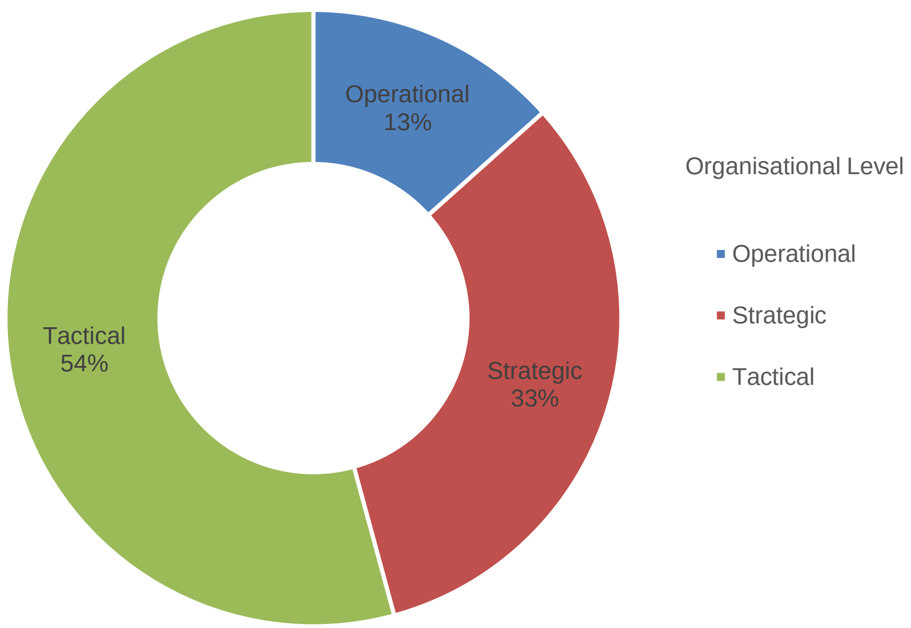


Figure 5:9 Distribution of respondent level in organization (n = 142)

This trend appears to suggest a gradual shift from the operational level towards the strategic level. This might be due to numerous conditions such as the appreciation of the need for a more strategic role played by FM in organisation. However, targeted data collection to explain the phenomenon will need to be accumulated as this is out of scope of this research.

5.4.2 Organisational Structure Analysis

The previous section argues that size has an effect on the structure of the organisation. This view has been elaborated by Mintzberg, (1979) who indicates that as size grows, several structural elaboration that follow the establishment of administrative hierarchy begins to develop. It has also been argued that uncertainty within and outside organisations influences the structural elaboration of organisations (Fang, Benamati, & Lederer, 2011; Jordan & Tricker, 1995; WILLMER, 1977). Uncertainty, on the other hand, emanates due to lack of appropriate information (Coulter, Ellins, Swain, Clarke, & Heron, 2006). Therefore, applying elaborate formal procedures and detailed strategies that enhance orderliness, consistency, and structure could reduce uncertainty (Fang et al., 2011). Redman, (1998) also found that the structure of the organisation was influenced by the quality of information within the organisation.

As the process of elaboration continues, the organisation turns to standardisation as a means of coordinating the work of its operators and reducing uncertainty (Mintzberg, 1979). These standardization are performed by analyst such as process analyst and quality control analyst, which bring in an administrative division of labour between those who do and those who supervise the work (Mintzberg, 1979). To this end, Mintzberg, (1979) provides a conceptual description of the structure of the organisation. These consist of five parts, which are the operating core, the middle line, the strategic apex, the technostructure, and support staff which reflects the level of the organisation discussed in section 5.4.1 (Figure 5:8). Drawing on the work of Mintzberg, (1979), Jordan & Tricker, (1995) condenses these parts by explaining that:

> *"…The operating core carries out the elementary functions of production of the organisation; it is supervised directly by the middle line, and the strategic apex includes senior management and members of the board. The technostructure consists of analysts, technologists and other specialists who are concerned with designing the work processes of others (mostly the operating core), generally to bring about standardisation. The support staffs provide support to the organisation outside the flow of productive work..."* (Jordan & Tricker, 1995)

According to Mintzberg, (1979), and Jordan, (1994) small organisation predominantly consists of strategic apex and operating core of which the strategic apex is the dominant part. This is known as a simple structure where there is a mainly informal two-way flow of information between these levels (Jordan & Tricker, 1995). Evidence from the analysis of the data in this study indicated that micro-organisations (less than 10 staffs) possessed this characteristic whereby 1.41% of the group at 95% confidence level made up the strategic and operational levels respectively (Table 5:14 and Figure 5:10). For small (11-50 staff) and medium (51-250 staff) size organisations, it was observed that the tactical level was dominant representing 10.56% and 35.21% of the group respectively at 95% confidence level. This level is akin to the middle line and the technostructure based on the structural configuration of Mintzberg, (1979). According to Mintzberg, (1979), the technostructure consist of analysts, technologists, and control experts which carry out standardisation of processes within the organisation. Their main sphere of influence for the technostructure is on the middle line management level of the organisation where they substitute standardisation for direct control (Mintzberg, 1979). Jordan & Tricker, (1995) noted that the technostructure is the dominant part exerting the most influence for large size organisations. However, this did not seem to be the case based on evidence from the analysis of organisations considered large in this study. Rather the technostructure expressed its self in organisation of medium and small size organisation based on the analysis. This might indicate a shift in the adoption of processes of standardisation in this size of organisations or a preponderance of organisations of this size operating in the FM industry. Further to this, the strategic level of small (11-50 staff) and medium (51-250 staff) organisations had values of 4.93% and 9.86% respectively at 95% confidence level. However, it was observed that the operation level was significantly more pronounced in medium sized (51-250 staff) organisations having 7.75% in comparison to 0.70% in small organisation despite having similar trends for both strategic and tactical levels at 95% confidence level (Table 5:14 and Figure 5:10). This might be attributed to the influence the support staff have on the operating core as indicated by Mintzberg, (1979). These support staff consist of highly trained professionals organised into professional teams, usually project based, to solve problems (Jordan & Tricker, 1995). Jordan & Tricker, (1995) noted that there is no organisation-wide control systems at this level hence the flow of information within this level is informal which might suggest a high level of poor quality information.

On the contrary, large sized organisation (staff = 251 and above) showed a deviation from the trends exhibited in micro, small and medium-sized organisations. It was seen that the predominant level for this type of organisation was the strategic level, which accounted for 16.20% of the sample group at 95% confidence level. This was followed by the tactical and operational levels having 8.45% and 3.52% of the sample group respectively at 95% confidence interval (Table 5:14 and Figure 5:10). In order to explain this phenomenon, further research needs to be conducted to see if this is as a result of the influence of the size of the organisation or some other factor such as organisations in this category predominantly operating a different business model e.g. outsource focus.

Table 5:14 Distribution of Level of Organisation on Organisation Size (n = 142)

Organisation Size Code	Organisation Size Description	Organisation Size	Organisation Level			Grand Total
			1 - Strategic	2 - Tactical	3 - Operational	
1	Micro	0 - 10	1.41%	0.00%	1.41%	2.82%
2	Small	11 - 50	4.93%	10.56%	0.70%	16.20%
3	Medium	51 - 250	9.86%	35.21%	7.75%	52.82%
4	Large	251 and above	16.20%	8.45%	3.52%	28.17%
Grand Total			32.39%	54.23%	13.38%	100.00%

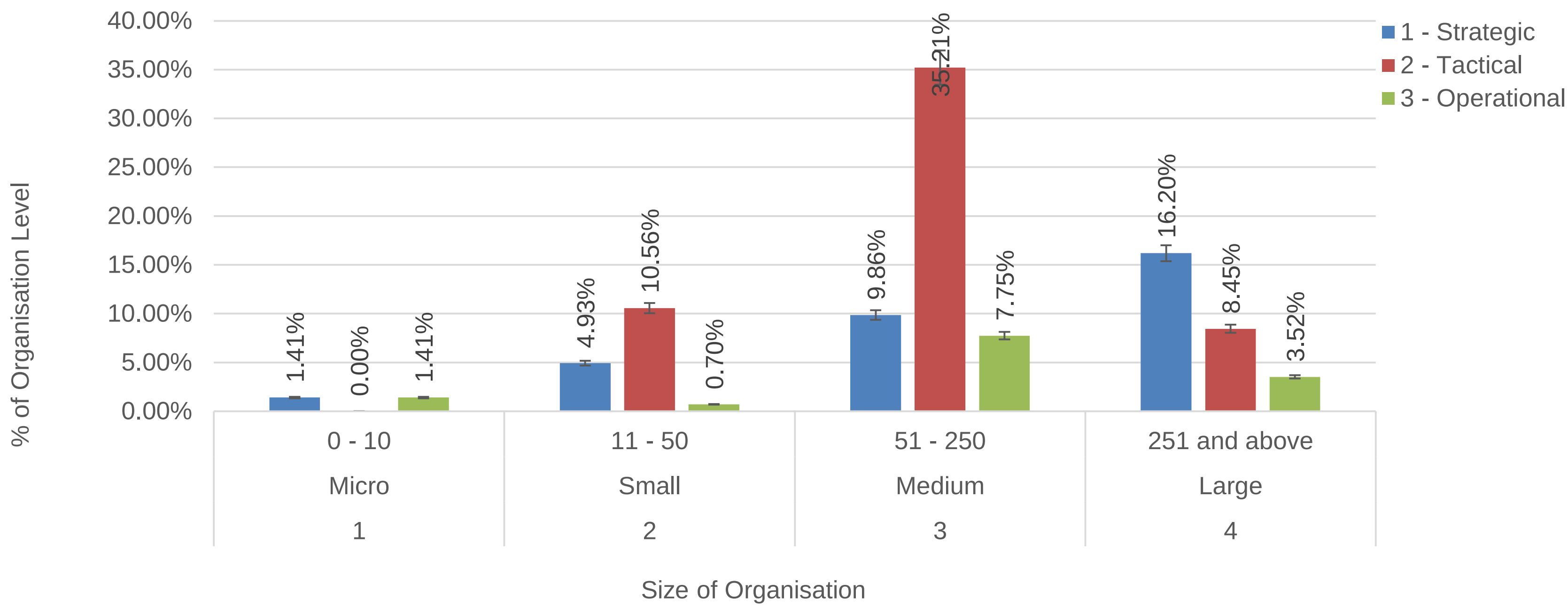


Figure 5:10 Distribution of Level of Organisation on Organisation Size (n = 142, Confidence Level = 95%)

In conclusion, it has been argued that organisation structure is influenced by several variables. The most significant of these is the size of the organisation. As Mintzberg, (1979) argued, as the organisation grows, it begins to develop elaborate structures to guide the flow of information. These elaborate structures are created to protect the organisation from uncertainties generated by the external environment (Jordan & Tricker, 1995; WILLMER, 1977). As the process of elaboration continues, the organisation achieves standardisation, orderliness, consistency by creating hierarchies that facilitates the flow of information and work (Fang et al., 2011; Mintzberg, 1979). These levels have been classified as the strategic, tactical, and operations level having the following parts respectively: strategic apex; middle line and technostructure; operating core and support staff (Jordan & Tricker, 1995). The detail and complexity of this structure is contingent on the size of the organisation. As seen from the analysis, micro-sized organisations had the simplest structure consisting of just two levels where information flow is two-way. Small and medium sized organisations structures were more elaborate where particular components were dominant. However, there was a variation in the large organisation where the strategic level was prominent. This serves as a motivation for further studies in organisation structure to investigate this phenomenon.

This research set out not only to determine and explain the structure of organisations within the FM industry but also to provide an empirical base for this explanation. As noted from the objectives of the study (see chapter 1), this research sought to determine the effect of organisation structure on information quality and also the prevalence of information quality issues experienced by FM practitioners performing AM functions. Hence, it is imperative to provide an empirical explanation to the influence of organisation structure on information quality and an empirical explanation of the prevalence of information quality issues in AM programs undertaken by FM organisation within the industry. To this end, the next section of this chapter presents the analysis of the prevalence of information quality issues and the effect of organisation structure on information quality. The analyses performed in the following section are frequency descriptive statistics, one-way ANOVA, and Factorial ANOVA (Field, 2013; J. Pallant, 2013).

5.5 RO2 – Prevalence of Information Quality Issue and Influence of Organisation Structure on Asset Information Quality in Facilities Management Industry

This section presents a comprehensive analysis of information quality in this study. It presents the results relating to the prevalence of information quality in FM organisation performing AM programs and the effect of FM organisation structure on information quality. Prior to these analyses, an examination of the structure of the organisations in relation the size and level was conducted.

Information plays a vital role in the survival of the organisation as it aids in managing uncertainty. According to Jordan, (1994) uncertainty is characterised by the unavailability of information. This leads individuals to form organisation which further modifies the structure of the formed organisation (Jordan, 1994). Though organisations come into existence because of information (Jordan, 1994), in the field of FM poor information quality exacerbates the overload of work (Jylhä & Suvanto, 2015). Jylhä & Suvanto, (2015) considers this as waste and classifies them as follow; overproduction, inventory, transportation, motion, over processing, defects, and waiting. Jylhä & Suvanto, (2015) also posits that poor information quality leads to actions based on the information being wrong and thus have a negative impact the value creation process. Therefore, high information quality has to ability to facilitate the improvement of services and reduce waste (Cai & Zhu, 2015).

Since information has the potential to affect the action of the organisation, its analysis enables users estimate the value that the information provides (Jylhä & Suvanto, 2015). In the same vein, the structure of the organisation should permit the free flow of information and the accompanying process (Sisk, 1977). In turn, the structure of the organisation is dependent on the information flow and technology within the organisation, whereby the degree of centralisation of information correlates strongly with that of organisation structure (Jordan, 1994). Since the organisation structure is an important predictor of information quality (Jordan & Tricker, 1995), the following section presents a critical analysis of the organisation structure in relation to size and level.

5.5.1 Prevalence of Information Quality Issue Analysis

In the previous section, the structure of FM organisations from the sample was examined, and the result demonstrated that the organisation structure ranged from very simple with 2 levels and less than 10 staff to very elaborate with three levels with more than 250 staff. However, what was to be determined was the effect the structure had on the quality of information of AM programs undertaken by the FM organisations. This section provides empirical evidence to this phenomenon. The section begins by analysing the prevalence of information quality issues in the FM industry by providing frequency statistic on this variable. The subsequent section further presents the ANOVA statistics in determining the effect of organisation structure on information quality.

It has been shown that organisations lacking high-quality information encounter increased costs in operations (Popovic & Habjan, 2012). Also, in their paper, Jylhä & Suvanto, (2015) showed the importance of analysing the quality of information. They argued that within the context of FM, poor quality of information results in waste due to overload of work. They further stated that poor information causes faulty information processing thus changing the value of information to negative. However, Jylhä & Suvanto, (2015) failed to determine if poor information quality is prevalent in the FM industry. In the same vein, Jones & White, (2012) and Kaya, (2011) provided recommendations for improving information quality but did not determine how prevalent an issue this is in FM. The analysis of the prevalence of information quality is, therefore, important because organisations need to know how significant the issue is and learn to react accordingly to the information in order to have a better understanding of their internal operations (Popovic & Habjan, 2012).

It must be noted that within the context of this research, the subject matter is AM and how this is affected by the quality of information. According to Amadi-Echendu, Willett, Brown, & Mathew, (2010) the poor quality of information is probably the most significant single factor impeding improvements in AM. Amadi-Echendu et al., (2010) go further to indicate that information quality is a core requisite for consistent AM outcomes. Evidence from this study indicates that there is a high prevalence of information quality issue affecting AM programs undertaken by FM.

From the output in Table 5:15, data from 142 valid questionnaires (respondents) was collected. This table provides critical information about the prevalence of information quality and the nature of the distribution of the issue experienced by FM professionals. The prevalence of information quality issues was measured on an 11-point Likert scale of 0 to 10 with 0 representing no information quality issue(s) and 10 representing high information quality issue(s). The prevalence of information quality issue had a range of 7 with 3 being the minimum and 10 the maximum. The mean value recorded was 7.89 while the median value was 8. It is recommended to report the median value in relation to the mean when describing descriptive statistics because the mean has the propensity to be affected by large quantities of extreme values or very skewed data which tend to pull the mean closer to those extremes thus giving a false representation (Tabachnick & Fidell, 2012). Invariably, this has an effect on the normal distribution of the data.

Table 5:15 Descriptive Statistics - Prevalence of Information Quality Issue

N	Valid	142
	Missing	0
	Mean	7.89
	Std. Error of Mean	0.123
	Median	8
	Mode	7
	Std. Deviation	1.467
	Variance	2.152
	Skewness	-0.457
	Std. Error of Skewness	0.203
	Range	7
	Minimum	3
	Maximum	10

Screening for normality was conducted by calculating the skewness and standard deviation of the sample. The distribution of the data was validated by the skewness which provided an indication of symmetry of the distribution, and the standard deviation which provided information about the spread of the data (J. Pallant, 2013). The results showed produced a skewness value of -0.457, and standard deviation (SD) of 1.467, which indicated that the scores were normally distributed and clustered closer to the centre and towards the right-hand side of the histogram graph (Figure 5:11). The normality of the distribution was subsequently supported by inspecting the Normal Q-Q plot which showed a straight line for the scores plotted against the expected value from the normal distribution (Figure 5:12).

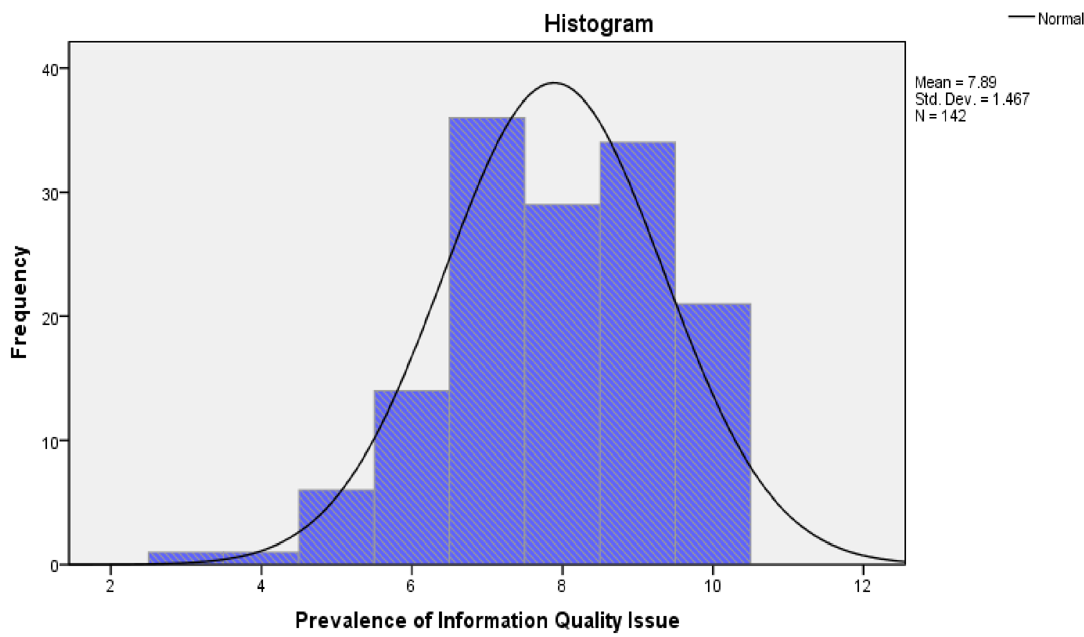


Figure 5:11 Prevalence of information quality issue (Likert Scale: 0 = Lowest; 10 = Highest)

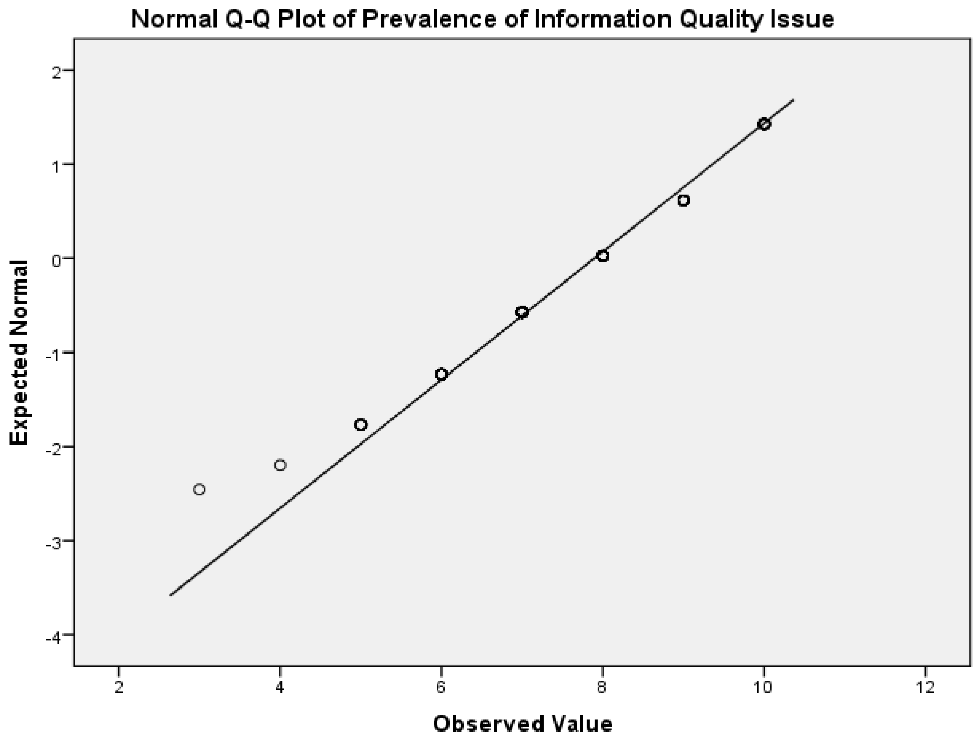


Figure 5:12 Normal Q-Q Plot of Prevalence of Information Quality Issue

Based on the distribution of data represented by the boxplot, 50% of the respondents reported information quality issues between the values of 7 and 9 (Figure 5:13). In addition, one extreme value (i.e. very low information quality issue) was also reported in the sample (Figure 5:13). This represented an outlier and on further investigation, it was observed that the respondent rated the quality of information at 3. However, this did not adversely affect the mean of the data because the mean value closely approximated the median. It can thus be established that the extremes values, though present, did not affect the normal distribution of the data.

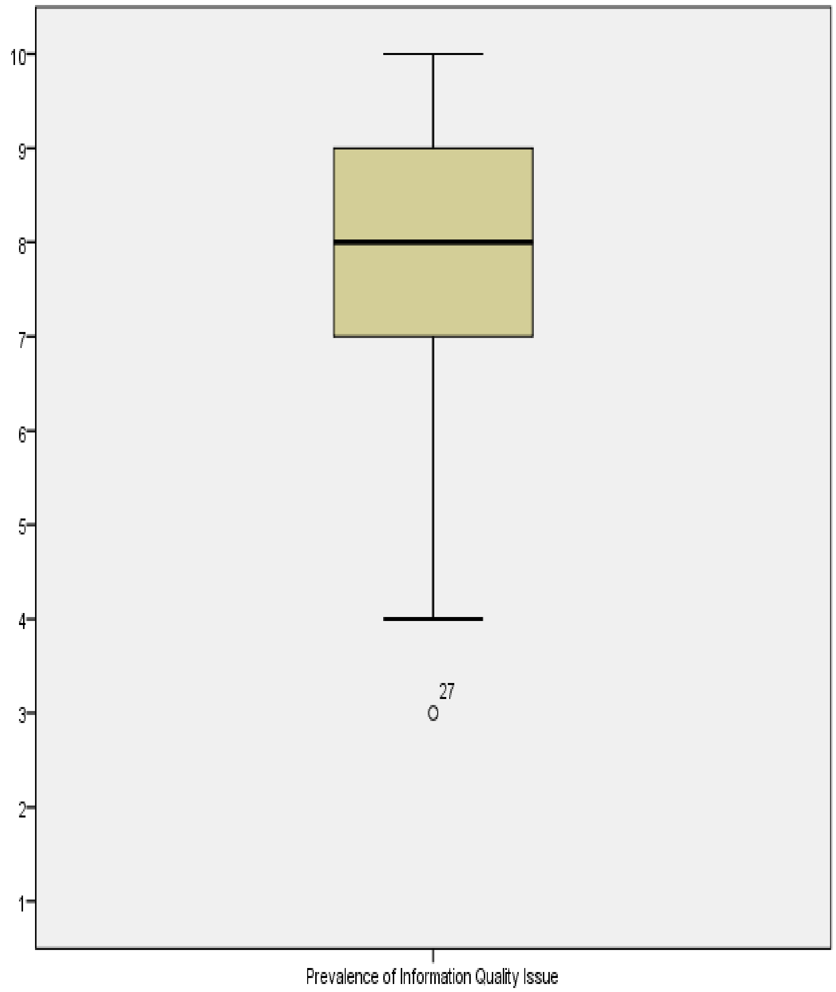


Figure 5:13 Boxplot of the distribution of the prevalence of information quality issue

Further examination of the frequency statistic table (Table 5:16) indicates that majority of the respondent (25.4%) specified an issue of information quality at point 7 on the Likert scale, which was followed by point 9 with 23.9% thus representing a high prevalence of information quality issue.

Table 5:16 Frequency statistic - prevalence of information quality issue

Valid	Frequency	Percent (%)	Valid Percent (%)	Cumulative Percent (%)
3	1	.7	.7	.7
4	1	.7	.7	1.4
5	6	4.2	4.2	5.6
6	14	9.9	9.9	15.5
7	36	25.4	25.4	40.8
8	29	20.4	20.4	61.3
9	34	23.9	23.9	85.2
10	21	14.8	14.8	100.0
Total	142	100.0	100.0	

From the result presented above, it can be concluded that there is a high prevalence of information quality issue affecting AM programs undertaken by FM organisations. This provides an empirical evidence to support anecdotal claims to issues of information quality (Amadi-Echendu et al., 2010; Jylhä & Suvanto, 2015). It can be observed that most issues of information quality are normally distributed and fall within one standard deviation from the mean as represented from the analysis. However, what this analysis does not tell is if there is any effect, due to size or organisation structure, on information quality. This is investigated in the next section to establish if the organisation size has an effect on information quality or if the organisation structure has an effect on information quality.

5.5.2 Effect of Organisation Structure and Size on Information Quality (One-Way ANOVA)

In section 5.4.2 the organisational structure was examined, and it was shown that as the size of the organisation grew, the structure became more elaborate. It was also observed that this might have an effect in the quality of information undertaken by FM when performing AM programs. In section 5.5.1 the prevalence of information quality issue affecting AM programs in FM organisation was explored but did not provide evidence of either the size or structure of the organisation having an effect on the prevalence of information quality affecting AM programs. The goal of this section goes further to provide the empirical evidence in determining if size or structure have an effect on the quality of information in AM programs undertaken by FM organisation. The analysis performed to determine this effect is the analysis of variance (ANOVA). This analysis is useful in detecting if a relationship or difference, based on the comparison of more than two groups having an independent variable and a dependent variable, is statistically significant[21] (Field, 2013; J. Pallant, 2013).

ANOVA is a parametric statistics which assumes that the underlying distribution of scores in the population from which the sample is taken is normal (J. Pallant, 2013). ANOVA is also used to compare differences between several means of different groups (Field, 2013). Based on these postulations, ANOVA is deemed the best statistics to be used as more than two groups have been identified in this study, {(1) size of organisation: micro, small, medium, and large; (2) level of organisation (structure): strategic, tactical, and operational}, and the data on prevalence of information quality issue is normally distributed (see sections 5.4.2 5.5.1 . The independent variables used in this analysis are organisation size and organisation structure, while the dependent variable is the prevalence of information quality. The specific type of ANOVA used in this section is the one-way between groups ANOVA with post-hoc test (J. Pallant, 2013). According to Pallant, (2013) one-way between groups ANOVA is used when there is one independent variable with three or more levels (groups) and one dependent continuous variable (Table 5:17).

Table 5:17 Schematic Description of One-Way Between-Groups ANOVA

	Group (Independent Variable)			
	Group $_1$	Group $_2$	Group $_3$	Group $_n$
Means Score (Dependent Continuous Variable)	$\dot{x}_1$	$\dot{x}_2$	$\dot{x}_3$	$\dot{x}_n$

The test establishes if there are significant differences in the mean scores on the dependent variable across the groups (J. Pallant, 2013). As an addendum, the following test were carried out to support the ANOVA test and further determine the significance

[21] Statistically significant: the phenomenon is not likely to have occurred by chance

of the effect of organisation size and structure on the prevalence of information quality: Descriptive, Test of Homogeneity of Variances, Robust Tests of Equality of Means, Multiple Comparisons, and Effect Size (Field, 2013; J. Pallant, 2013).

5.5.2.A Effect of Organisation Structure on Information Quality Prevalence

A one-way ANOVA test was conducted to explore the effect of FM organisation structure on the prevalence of information quality issues in AM programs. The variables that determined the structure of the organisation were the hierarchical levels, which include: (1) the strategic level, (2) the tactical level, and (3) the operational level (Table 5:18). The mean for each level respectively was 8.15, 7.97, and 6.95 having standard deviation of 1.366, 1.386, and 1.715 respectively. In the regard, the strategic level reported that highest prevalence of information quality issue while the operational level reported the lowest prevalence of information quality issue (Figure 5:14). However, this neither stated how statistically significant the differences in the levels were, nor the effect these levels had on information quality. Hence further test were carried out to determine these effects.

Table 5:18 Descriptive Statistic for Prevalence of Information Quality Issue due to Organisation Level

Level	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Strategic	46	8.15	1.366	.201	7.75	8.56	4	10
Tactical	77	7.97	1.386	.158	7.66	8.29	5	10
Operational	19	6.95	1.715	.393	6.12	7.77	3	10
Total	142	7.89	1.467	.123	7.65	8.14	3	10

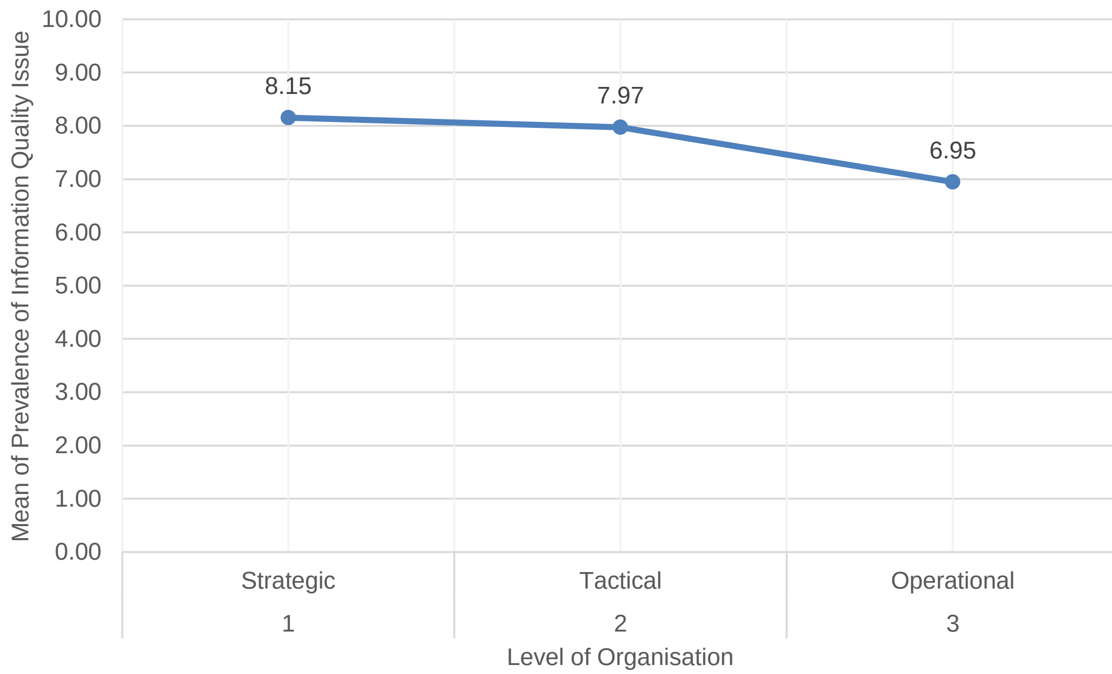


Figure 5:14 Mean Prevalence of IQ Issue due to Organizational Level (n=142)

The variability of the scores for each level was found to be similar based on the Levene's test of homogeneity (Table 5:19). This test produced a Sig. value of .498 which is greater than .05 indicating the test was is not significant and therefore not to have violated the assumption of homogeneity of variance (Field, 2013; J. Pallant, 2013). This was further supported by the Welch and Brown-Forsythe test (Table 5:20) which produced significant values (Sig.) of .032 and .017 respectively.

Table 5:19 Test of Homogeneity of Variances for Prevalence of Information Quality Issue due to Organisation Level

Levene Statistic	df1	df2	Sig.
.702	2	139	.498

Table 5:20 Robust Tests of Equality of Means for Prevalence of Information Quality Issue due to Organisation Level

	Statistic[a]	df1	df2	Sig.
Welch	3.707	2	46.021	.032
Brown-Forsythe	4.391	2	54.108	.017

a. Asymptotically F distributed.

Based on the ANOVA test (Table 5:21), there was a statistically significant difference between the levels of the organisation at the $p < .05$ in the scores for the three levels: F (2,139) = 5.058, p = .008.

Table 5:21 ANOVA for Prevalence of Information Quality Issue due to Organisation Level

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	20.585	2	10.293	5.058	.008
Within Groups	282.830	139	2.035		
Total	303.415	141			

The level(s) that differed in this test are presented in the post-hoc test (Table 5:22). Based on this test, it was observed that the levels i.e. strategic, tactical, and operational levels, were statistically significantly different from one another at the $p<.05$ level in terms of their IQ prevalence issue score. The statistically significant differences are stated as follows:

1. The strategic level was statistically significantly different from the operational level (Sig. = .007)
2. The tactical level was statistically significantly different from the operational level (Sig. = .016)
3. The operational level was statistically different from the strategic and tactical level (Sig. = .007 and .016 respectively)

Table 5:22 Multiple Comparisons for Prevalence of Information Quality Issue due to Organisation Level

Dependent Variable: Prevalence of Information Quality Issue

Tukey HSD

(I) Level of the organisation	(J) Level of the organisation	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Strategic	Tactical	.178	.266	.781	-.45	.81
	Operational	1.205*	.389	.007	.28	2.13
Tactical	Strategic	-.178	.266	.781	-.81	.45
	Operational	1.027*	.365	.016	.16	1.89
Operational	Strategic	-1.205*	.389	.007	-2.13	-.28
	Tactical	-1.027*	.365	.016	-1.89	-.16

*. The mean difference is significant at the 0.05 level.

To assess the importance of this finding, the effect size (eta squared) between the groups was calculated. This explained the strength of association between the dependent variable (information quality prevalence) and the independent variable (level of the organisation). The effect size was calculated, based on the values obtained from the ANOVA test which are the sum of squares between groups and the total sum of squares (Table 5:21), using the formula (Equation 5:3).

$$\eta^2 = \frac{SS_M}{SS_T}$$

Equation 5:3 Effect Size

Where:

- η^2 = effect size (eta squared)
- SS_M = sum of squared between groups
- SS_T = total sum of squares

The value of the calculated effect size was then compared to the Eta Squared value of the *Cohen's d* guideline on effect size (Table 5:23) (J. Pallant, 2013).

Table 5:23 Cohen's d Guideline on Effect Size (Julie Pallant, 2013)

Effect Size	Eta Squared	% of variance explained	Cohen's d (Standard deviation units)
Small	0.01	1	0.2
Medium	0.06	6	0.5
Large	0.14	13.8	0.8

The resulting eta squared value based on the calculation of the effect size was .068, which indicates a medium size effect based on Cohen's d recommendation. Therefore, it can be inferred that though there was a significant difference between the levels of organisations on the prevalence of information quality, the actual difference in mean scores between the groups had a mild effect on the prevalence of information quality issue based on the Cohen's d value. This is shown in the effect size calculated using eta squared, which gave a result of .068. The Post-hoc comparison using the Tukey HSD test indicated that the mean score for the strategic level (M = 8.15, SD = 1.366) was significantly different from the operational level (M = 6.95, SD = 1.715), while the mean score for the tactical level (M = 7.97, SD = 1.386) was significantly different from the operational level (M = 6.95, SD = 1.715). The operational level (M = 6.95, SD = 1.715) was found to be significantly different from both strategic level (M = 8.15, SD = 1.366) and tactical level (M = 7.97, SD = 1.386). Hence, it was concluded that FM organisational structure does have an effect on the quality of information used in AM programmes.

5.5.2.B Effect of Organisation Size on Information Quality Prevalence

A second one-way ANOVA test was conducted to explore the effect of FM organisation size on the prevalence of information quality issues in AM programs. The variables that determined the size of the organisation were as follows: (1) Micro: 0- 10, (2) Small: 11-50, (3) Medium: 51-250, and (4) Large: 251 and above. The mean for each size respectively was 7.00, 7.83, 7.85, and 8.10 having standard deviation of 3.559, 1.230, 1.332, and 1.566 respectively (Table 5:24). In this regard, organisations with size of 251 and above reported that highest prevalence of information quality issue while the micro size organisations reported the lowest prevalence of information quality issue (Figure 5:15). Small and medium sized organisation had very similar means of 7.83 and 7.85 respectively with SD of 1.230 and 1.332. Overall, the differences between the means were very small. This neither stated how statistically significant the differences in the size of the organisations were nor the effect these sizes had on information quality. This led to further test being carried out.

Table 5:24 Descriptive Statistic for Prevalence of Information Quality Issue due to Size of Organisation

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
0 - 10	4	7.00	3.559	1.780	1.34	12.66	3	10
11 - 50	23	7.83	1.230	.257	7.29	8.36	6	10
51 - 250	75	7.85	1.332	.154	7.55	8.16	5	10
251 and above	40	8.10	1.566	.248	7.60	8.60	4	10
Total	142	7.89	1.467	.123	7.65	8.14	3	10

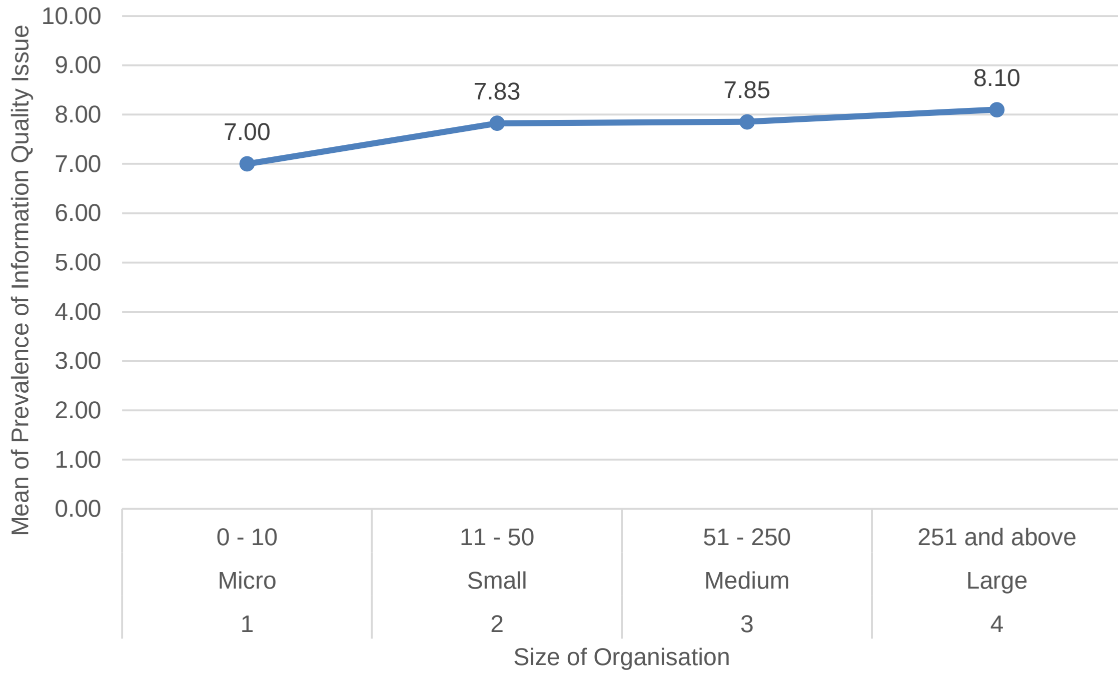


Figure 5:15 Mean Prevalence of IQ Issue due to Organizational Size (n=142)

The variability of the scores for each size of organisation was found to be dissimilar based on the Levene's test of homogeneity (Table 5:25). This test produces a Sig. value of .000 which is less than .05 indicating the test was significant and therefore violated the assumption of homogeneity of variance (Field, 2013; J. Pallant, 2013). This was further supported by the Welch and Brown-Forsythe tests (Table 5:26) which produced significant values (Sig.) of .805 and .813 respectively.

Table 5:25 Test of Homogeneity of Variances for Prevalence of Information Quality Issue due to Organisation Size

Levene Statistic	df1	df2	Sig.
7.939	3	138	.000

Table 5:26 Robust Tests of Equality of Means for Prevalence of Information Quality Issue due to Organisation Size

	Statistic[a]	df1	df2	Sig.
Welch	.328	3	13.252	.805
Brown-Forsythe	.317	3	5.164	.813

a. Asymptotically F distributed.

Based on the ANOVA test (Table 5:27), there were no statistically significant difference between the size of the organisation at the p<.05 in the scores for the four groups: *F* (3,138) = .790, p = .501.

Table 5:27 ANOVA for Prevalence of Information Quality Issue due to Organisation Size

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	5.124	3	1.708	.790	.501
Within Groups	298.291	138	2.162		
Total	303.415	141			

On further examination of the multiple comparisons table (Table 5:28), it was observe that there was no difference between the sizes of organisation in terms of their IQ prevalence issue score.

Table 5:28 Multiple Comparisons for Prevalence of Information Quality Issue due to Organisation Size

Dependent Variable: Prevalence of Information Quality Issue

Tukey HSD

(I) Size of Organisation	(J) Size of Organisation	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
0 - 10	11 - 50	-.826	.796	.728	-2.90	1.25
	51 - 250	-.853	.754	.671	-2.82	1.11
	251 and above	-1.100	.771	.485	-3.11	.91
11 - 50	0 - 10	.826	.796	.728	-1.25	2.90
	51 - 250	-.027	.350	1.000	-.94	.88
	251 and above	-.274	.385	.892	-1.27	.73
51 - 250	0 - 10	.853	.754	.671	-1.11	2.82
	11 - 50	.027	.350	1.000	-.88	.94
	251 and above	-.247	.288	.827	-1.00	.50
251 and above	0 - 10	1.100	.771	.485	-.91	3.11
	11 - 50	.274	.385	.892	-.73	1.27
	51 - 250	.247	.288	.827	-.50	1.00

In assessing the importance of this finding, the effect size was calculated, and the resulting eta squared value based on the calculation of the effect size was .017, which indicates a small size effect based on Cohen's d recommendation.

In conclusion, there was not a significant difference between the size(s) of organisations on the prevalence of information quality measure. In addition, the difference in mean scores between the groups had a very small effect on the prevalence of information quality issue based on the Cohen's d value. The effect size calculated using eta squared, was .017, which indicated a small effect. Post-hoc comparison using the Tukey HSD test did not indicate any significant difference.

5.5.3 Combined Effect of Organisation Structure and Size on Information Quality Prevalence using Factorial ANOVA

As it has been observed in the preceding section, the structure of the organisation was seen to have an effect on the quality of information used in AM programs undertaken by FM organisation. Nonetheless, this effect was not expressed based on the size of the organisations. In addition, it was not known if there was an interaction effect between the variables i.e. if the size of the organisation influenced the structure of the organisation or vice versa thereby causing the effect on the quality of information.

It has been noted that the organisation structure facilitates the understanding and the flow of information within the organisation (Jordan & Tricker, 1995). Mintzberg, (1979), however, noted that as the organisation grows in size, several structural elaboration begins to emanate. In turn, such structural elaboration and growth in size have been posited to affect the quality of information that flows within the organisation (Haug et al., 2013; WILLMER, 1977). Within the field of FM, this effect has not been investigated and as such, it cannot be said that this is to be the case. In essence, it is not known if there is an interaction effect between the size of the organisation and the levels of the organisation on the quality of information. Hence, the purpose of this section is to determine what the effect of organisation size and level on the prevalence of information quality issue is in AM programs, and if the organisation size moderates the relationship between the organisational level and the prevalence of information quality issues.

According to Field, (2013), the combined effect of two or more predictor variables on an outcome variable is known statistically as an interaction effect. Field, (2013) also noted that it can be used to gauge moderation. An interaction effect occurs when the effect of one independent variable on the dependent variable depends on the level of a second independent variable. From the previous section, the independent variables were determined to be organisation levels and the organisation sizes, while the dependent variable was the prevalence of information quality issue. To determine the interaction effect, a Factorial ANOVA (Two-way between-group ANOVA) analysis was conducted using SPSS ver. 22 (Field, 2013; J. Pallant, 2013). This technique facilitates the investigation of the individual (main) and joint (interaction) effect of the two independent variable on the dependent variable and determine if this effects are statistically significant in FM organisation (J. Pallant, 2013). Based on the analysis, the mean and standard deviation for each group was calculated respectively (Table 5:29). This neither stated how statistically significant the differences in the groups were nor the effect they had on information quality.

Table 5:29 Descriptive Statistic for Prevalence of Information Quality Issue Due To Size and Level of Organisation (n = 142)

Dependent Variable: Prevalence of Information Quality Issue

Level of the organisation	Size of Organisation	Mean	Std. Deviation	N
Strategic	0 - 10	10.00	.000	2
	11 - 50	7.86	1.464	7
	51 - 250	8.21	1.311	14
	251 and above	8.04	1.364	23
	Total	8.15	1.366	46
Tactical	11 - 50	7.80	1.207	15
	51 - 250	7.92	1.307	50
	251 and above	8.42	1.881	12
	Total	7.97	1.386	77
Operational	0 - 10	4.00	1.414	2
	11 - 50	8.00	.	1
	51 - 250	7.09	1.300	11
	251 and above	7.60	1.817	5
	Total	6.95	1.715	19
Total	0 - 10	7.00	3.559	4
	11 - 50	7.83	1.230	23
	51 - 250	7.85	1.332	75
	251 and above	8.10	1.566	40
	Total	7.89	1.467	142

The Levene's test of equality of error variances was performed to test the assumption of homogeneity of variances for each group (J. Pallant, 2013). This produces a Sig. value of .129, which was greater than .05 (Table 5:30). This indicated that the assumption was not violated, and suggests that the variances of the dependent variable across the groups were equal.

Table 5:30 Levene's Test of Equality of Error Variances

Dependent Variable: Prevalence of Information Quality Issue

F	df1	df2	Sig.
1.549	10	131	.129

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Design: Intercept + Organisation_Level + Organisation_Size + Organisation_Level * Organisation_Size

The interaction effect was calculated to determine if the organisation size moderates the relationship between the organisational level and the prevalence of information quality issues (Table 5:31). It was observed that there was a statistically significant interaction effect (p<.05) between the organisation level and the size of the organisation on the prevalence of information quality issue, $F(5,131) = 3.002$, p = .013, Partial Eta Squared (η^2) = .103. This indicated that the level of the organisation was affected differently by the size of the organisation. Hence, the influence of organisation level on information quality depended on the size of the organisation i.e. micro, small, medium, or large.

Table 5:31 Tests of Between-Subjects Effects

Dependent Variable: Prevalence of Information Quality Issue

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	52.139[a]	10	5.214	2.718	.005	.172
Intercept	2516.429	1	2516.429	1311.910	.000	.909
Organisation_Level	22.939	2	11.469	5.979	.003	.084
Organisation_Size	3.509	3	1.170	.610	.610	.014
Organisation_Level * Organisation_Size	28.789	5	5.758	3.002	.013	.103
Error	251.277	131	1.918			
Total	9153.000	142				
Corrected Total	303.415	141				

a. R Squared = .172 (Adjusted R Squared = .109)

The main effect was determined for each independent variable that explained which of the independent variable influenced the dependent variable strongly. It was observed from the analysis that there was a statistically significant main effect for the organisation level, $F(2, 131) = 5.979$, p = .003, and Partial Eta Squared (η^2)[22] = .084 (Table 5:31). The effect of the organisation size was not statistically significant, $F(3, 131) = .610$, p = .610, and Partial Eta Squared (η^2)[23] = .014 (Table 5:31). Based on these result, it was concluded that there was a statistically significant main effect for the organisation level, where this effect was deemed large. Results from the post-hoc comparisons using the Tukey HSD test indicated that the mean score for the strategic level (M = 8.15, SD = 1.366) was significantly different from the operational level (M = 6.95, SD = 1.715), p = .005 (Table 5:32). Also, the mean score for the tactical level (M = 7.97, SD = 1.386) was

[22] Partial Eta Squared (η^2) = .084 indicates a high effect size based on Cohen's d criteria
[23] Partial Eta Squared (η^2) = .014 indicates a small effect size based on Cohen's d criteria

significantly different from the operational level (M = 6.95, SD = 1.715), p = .012. Finally the mean score for the operational level (M = 6.95, SD = 1.715) was significantly different from the strategic level (M = 8.15, SD = 1.366), p = .005 and, the tactical level (M = 7.97, SD = 1.386), p = .012 (Table 5:32).

Table 5:32 Multiple Comparisons for Organisation Level

Dependent Variable: Prevalence of Information Quality Issue

Tukey HSD

(I) Level of the organisation	(J) This is the level of the organisation	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Strategic	Tactical	.18	.258	.770	-.43	.79
	Operational	1.20*	.378	.005	.31	2.10
Tactical	Strategic	-.18	.258	.770	-.79	.43
	Operational	1.03*	.355	.012	.19	1.87
Operational	Strategic	-1.20*	.378	.005	-2.10	-.31
	Tactical	-1.03*	.355	.012	-1.87	-.19

Based on observed means.

The error term is Mean Square(Error) = 1.918.

*. The mean difference is significant at the .05 level.

There was no statistically significant difference for the size of the organisation from the post-hoc comparisons using the Tukey HSD test (Table 5:33)

Table 5:33 Multiple Comparisons for Organisation Size

Dependent Variable: Prevalence of Information Quality Issue

Tukey HSD

(I) Size of Organisation	(J) Size of Organisation	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
0 - 10	11 - 50	-.83	.750	.690	-2.78	1.13
	51 - 250	-.85	.711	.628	-2.70	1.00
	251 and above	-1.10	.726	.432	-2.99	.79
11 - 50	0 - 10	.83	.750	.690	-1.13	2.78
	51 - 250	-.03	.330	1.000	-.89	.83
	251 and above	-.27	.362	.874	-1.22	.67
51 - 250	0 - 10	.85	.711	.628	-1.00	2.70
	11 - 50	.03	.330	1.000	-.83	.89
	251 and above	-.25	.271	.800	-.95	.46
251 and above	0 - 10	1.10	.726	.432	-.79	2.99
	11 - 50	.27	.362	.874	-.67	1.22
	51 - 250	.25	.271	.800	-.46	.95

Based on observed means.

The error term is Mean Square(Error) = 1.918.

Thus, it can be concluded that the structure of the organisation had a strong influence on the quality of information but was moderated by the size of the organisation.

5.6 RO4 – Identifying Information Quality Dimension Specific to AM in Facilities Management Operation

The previous section provided a detailed analysis of the effect of organisation structure and size on the quality of information in AM programmes undertaking by FM organisations. It was observed that the structure of the organisation had an effect on the quality of information used in AM programmes. However, the quality of information has been attributed to specific dimensions, known as information quality dimensions; that confers effectiveness of AM programmes (Koronios et al., 2005). This section thus seeks to determine those IQ dimensions specific to AM programs undertaken by facilities management organisations.

IQ dimensions are latent constructs, which constitute measurable attributes expressed within the context of an operation. As such, there are as many IQ attributes as there are actors. Those attributes of IQ are derivatives of the relationships that exist between social actors and their technical environment. Therefore, obtaining the viewpoints of the actors with reference to perceived quality of information is crucial.

Existing studies suggest that practitioners evaluate IQ based on the dimensions of (1) accessibility, (2) availability, (3) content, (4) cost, (5) effectiveness, (6) form, (7) time and (8) validity. Thus, 83 IQ attributes comprising of *8 accessibility attributes, 4 availability attribute, 28 content attribute, 1 cost attribute, 9 effectiveness attribute, 15 form attribute, 5 time attribute, and 13 validity attribute* have been identified from literature and were used to capture the respondents' perception of IQ (Appendix IX).

Sebastian-Coleman, (2013) suggests that there is no consensus on the quality dimension of information. More worryingly is the disparity between the identified dimensions and the context in which this occurs. Though previous studies have elicited dimensions to information quality, robust empirical techniques to such findings have been limited. For instance, R. W. Wang et al., (1996) study on IQ presented dimensions that possessed limited meaning when applied in real world context. Chaffey & Wood, (2005) attempted to classify these IQ attributes into specific dimension. However, this resulted in three identified dimension. Lee & Levy, (2014) study on information quality produced 33 attributes of IQ. Herrala, (2007) however attempted to consolidate IQ dimension into meaningful construct, but this lacked an empirical basis. The results of these studies produced IQ dimensions subsumed within a narrow context.

This study presents findings that identifies attributes of IQ (see chapter 4) and empirically classifies these attributes to reveal the latent constructs accounted for by these attributes i.e. the IQ Dimensions. The next section presents the process of identification of the information quality dimensions.

5.6.1 Identifying IQ Dimension

The second phase of the study commenced with the identification of the IQ dimensions. 83 IQ attributes, identified from the interview and literature, were included in the structured questionnaire formulated as a 5-point Likert scale measurement (Appendix VIII). The question asked in the questionnaire were as follows; "*Please rate the importance of the following IQ attribute to your job (with the ratings as follows: 1 = Least Importance, 2 = Low Importance, 3 = Moderate Importance, 4 = Very Important, 5 = Extremely Important)*".

Determining the actual sample size for PCA have been fraught with intense debate (Conway & Huffcutt, 2003; Fabrigar et al., 1999; Field, 2013; Floyd & Widaman, 1995). For example, Fabrigar et al., (1999) noted that sample size for PCA have been based on the participant-to-variable ratio of 5:1. This view has been echoed by Floyd & Widaman, (1995). However, Field, (2013) argued that this approach lack an empirical basis and recommended the use of the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy in determining the adequacy of the sample used. According to Field, (2013) the KMO statistic for each variable is calculated and represents values between 0 and 1. Table 5:34shows the guideline when using KMO for evaluating sample size (Field, 2013):

Table 5:34 KMO Sampling Adequacy Value

Indication	KMO Value
Excellent	0.90
Very Good	0.80
Good	0.70
Weak	0.60
Very Weak	0.50
Unacceptable	>0.50

Field, (2013) further added that any value below 0.50 should lead to the collection of more data or inclusion of variables to be measured. Sample sizes of 150 is judged sufficient when solutions show several KMO values of >0.80 (J. F. Pallant & Bailey, 2005).

In this study, 142 valid responses were obtained from the distribution of the questionnaire giving a response rate of 42.22% (see section 5.2.4). A quantitative analysis was conducted to determine the underlying IQ dimension that accounted for the identified attributes. This was achieved by conducting an Exploratory Factor Analysis using PCA. 83 IQ attributes of the questionnaire were subjected to PCA with Oblique Rotation (Direct Oblimin) using SPSS version 22. Prior to analysis, the attributes were grouped into specific dimensions based on evidence from the literature (Chaffey & Wood, 2005; Herrala, 2007; R. W. Wang et al., 1996). The analysis was used to reveal the key dimension of IQ and handle the multi-collinearity problem that may have risen due to inter-correlations among the 83 IQ attributes (Ibem & Alagbe, 2015).

The suitability of the data for PCA was assessed through the inspection of the correlation matrix for each identified IQ attribute. This revealed the presence of many coefficients of 0.3 and above. The KMO for the extracted IQ dimensions groups were 0.892, 0.808, 0.879, 0.901, 0.893, 0.750, 0.739 respectively (Table 5:35), which suggested a sampling adequacy above the limit of 0.6 (Field, 2013). The Bartlett's Test of Sphericity reached statistical significance, p=.000, for each group supporting the factorability of the correlation matrix (J. Pallant, 2013). Based on these values, it was concluded that the data was suitable for PCA.

The PCA was run to obtain eigenvalues for each component in the data based on the identified grouping structure (Appendix IX). By using PCA, it was possible to ascertain the maximum number of components to retain and visualise the clustering of each attribute to specific component. The principal component analysis revealed the presence of 12 components with eigenvalues over Kaiser's criterion of 1, explaining 37.15%, 9.1%, 40.25%, 11.20%, 37.47%, 8.18%, 37.35%, 6.29%, 38.22%, 8.51%, 44.24%, and 44.70% of the variance respectively (Table 5:35).

Table 5:35 Identified Information Quality Dimensions Using Principal Component Analysis

IQ Dimension Category	K.M.O[24]	Sig.[25]	Dimension (Component)	Initial Eigenvalues			Attributes	Factor Loading
				Eigenvalue	% of Variance	Cumulative %		
Dependable	0.892	0.000	Reputation	4.829	37.145	37.145	Measured Against a Set Standard	0.809
							Interrogatory	0.787
							Sensitive	0.724
							Reputation	0.663
							Standardized	0.564
							Traceability	0.505
							Objectivity	0.345
			Validity	1.184	9.107	46.252	Objectivity	0.338
							Correct	0.789
							Auditable	0.728
							Trustworthy	0.721
							Confident	0.540
							Verifiable	0.533
							Believability	0.425
Security	0.808	0.000	Accessibility	3.622	40.250	40.250	Source	0.808
							Accessible	0.737
							Shareable	0.708
							Collaborative	0.610
							Compatible	0.511
			Available	1.008	11.204	51.454	Visible	0.787
							Protected	0.747

[24] Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO) = ≥ 0.600
[25] Bartlett's Test Of Sphericity (Test of significance of factor analysis) = ≤ 0.05

							Available	0.593
							Secure	0.545
Operational	0.879	0.000	Effectiveness	4.871	37.470	37.470	Value	0.809
							Gap Free	0.673
							Streamlined	0.656
							Transmitted Seamlessly	0.651
							Flexibility	0.641
							Ease of Operation	0.508
							Interoperable	0.470
							Manageable	0.451
			Robustness	1.063	8.178	45.648	Methodical	0.759
							Easily Manipulated	0.692
							Robust	0.653
							Organized	0.640
							Granular	0.586
Usable	0.901	0.000	Content	7.843	37.349	37.349	Generic	0.850
							Good	0.710
							Perfect	0.707
							Best Quality	0.701
							Full	0.574
							Supplementary	0.574
							Directed	0.481
							Interpretability	0.468
							Accurate	0.414
							In-Depth	0.330
							Parameters	0.353
			Scope	1.321	6.290	43.639	Relevance	0.888

							Readable	0.747
							Complete	0.665
							Uniform	0.568
							Comprehensive	0.535
							Informed	0.467
							Hierarchical	0.458
							Mandatory	0.429
							Fine-Tuned	0.412
							Purpose	0.411
							In-Depth	0.407
							Parameters	0.399
Aesthetic	0.893	0.000	Visualisation	5.351	38.218	38.218	Plain	0.859
							Personalized	0.807
							Structured	0.782
							Presentation	0.575
							Representational	0.561
							Ease Of Understanding	0.451
							Familiarity	0.395
							Perception	0.386
			Form	1.192	8.512	46.731	Familiarity	0.329
							Perception	0.314
							Readable	0.756
							Understand	0.755
							Detailed	0.664
							Consistent	0.648
							Format	0.628
							Well-Presented And Organised	0.523

Currency	0.750	0.000	Time	2.212	44.243	44.243	Priority	0.723
							Frequency	0.697
							Updated	0.691
							Historical	0.613
							Timeliness	0.592
Volume	0.739	0.000	Volume	2.235	44.700	44.700	Adequate	0.706
							Appropriate Amount	0.701
							Sufficient	0.649
							Enough	0.644
							Little	0.640

5.6.2 IQ Dimension Identification and Naming Convention

Research has acknowledged that appropriate naming of information quality dimension is a persistent challenge as this is fraught with ambiguity and subjectivity (Alenezi et al., 2015; R. J. Price & Shanks, 2005). As noted in the existing literature on information quality, the choice of naming is often based on practitioners intuition, experience or literature (R. J. Price & Shanks, 2005; Wand & Wang, 1996). On acknowledging this challenge Wand & Wang, (1996) proposed an ontological foundation to information quality dimension while (R. J. Price & Shanks, 2005) proposed a semiotic approach. However, the limitation to these methods is the complexity in understanding these by non-theorist. Thus this research argues that a contextual approach to determining an appropriate naming convention is required. This approach relies on the operational context where information is generated, transmitted, and used for various specific task or activity. This further argues that a contextual approach to naming dimensions of information quality provides a meaningful context understood by actors within a specific operation situation. For instance, a designer who is interested in attributes of presentation, representation, and perception may consider these as Aesthetic Category.

Determining the maximum number of dimension to retain was facilitated by the scree-plot for each component. The decision of the appropriate IQ dimensions terminology was aided by the affinity of individual IQ attributes and the semantic interpretation of the individual attributes constituting each IQ dimension. In addition to this, the examination of the attributes constituted within each dimension was mapped to the operational context where each information quality attribute were identified. This further aided the appropriate terminology for each dimension cluster. Finally, the component plot in rotated space chart achieved further clustering of each IQ dimension.

5.6.2.A Dependable (Reputation-Validity) Category

The information quality attributes making up the dependable category refers to conformity to specification and the reliability representative of the information assessed after the information is delivered within the operational context. For the Dependable (Reputation-Validity) category, the inspection of the screeplot revealed an inflexion after the second component supporting the decision to retain two components (Figure 5:16).

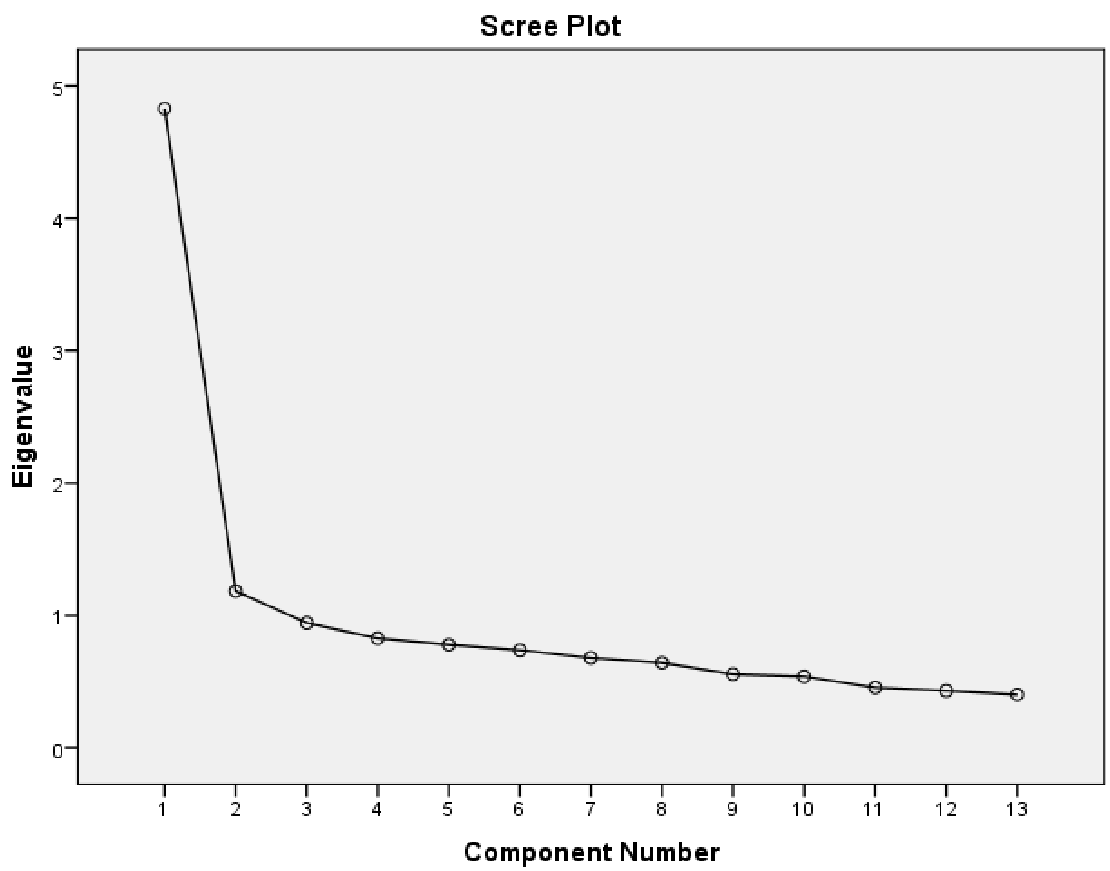


Figure 5:16 Screeplot for the Dependable (Reputation-Validity) Category

The two-component solution explained 46.25% of the variance, with the Reputation component contributing 37.15%, and Validity component contributing 9.10% of the variance. In order to understand the interpretation of these two component, a direct oblimin rotation was performed revealing the presence of a simple structure with both component showing a number of attributes strongly loading on each component (Figure 5:17).

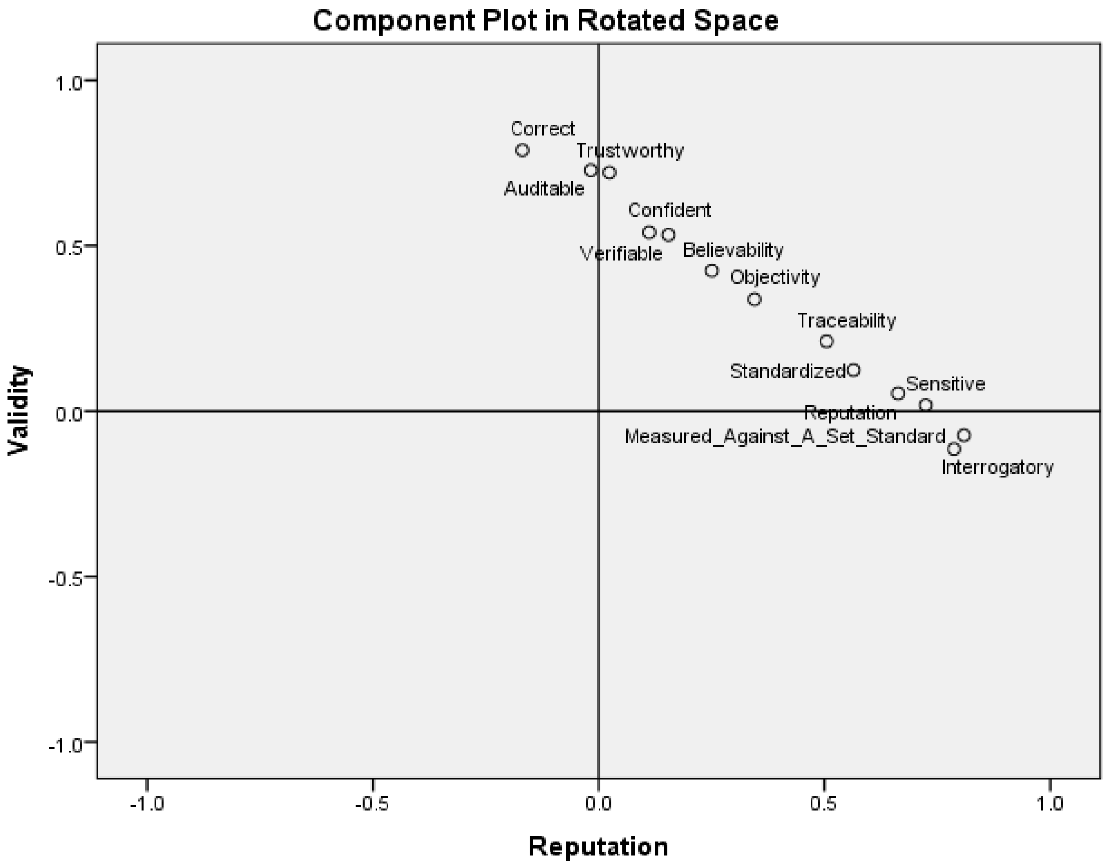


Figure 5:17 Component Plot in Rotated Space for Reputation-Validity IQ Dimensions

5.6.2.B Security (Accessibility-Availability) Category

The information quality attributes making up the security category refers to the extent the information confers a level of confidentiality with the ease of obtaining it for particular operational activity. For the Security (Accessibility-Availability) category, the inspection of the screeplot revealed an inflexion after the second component supporting the decision to retain two components for further investigation (Figure 5:18).

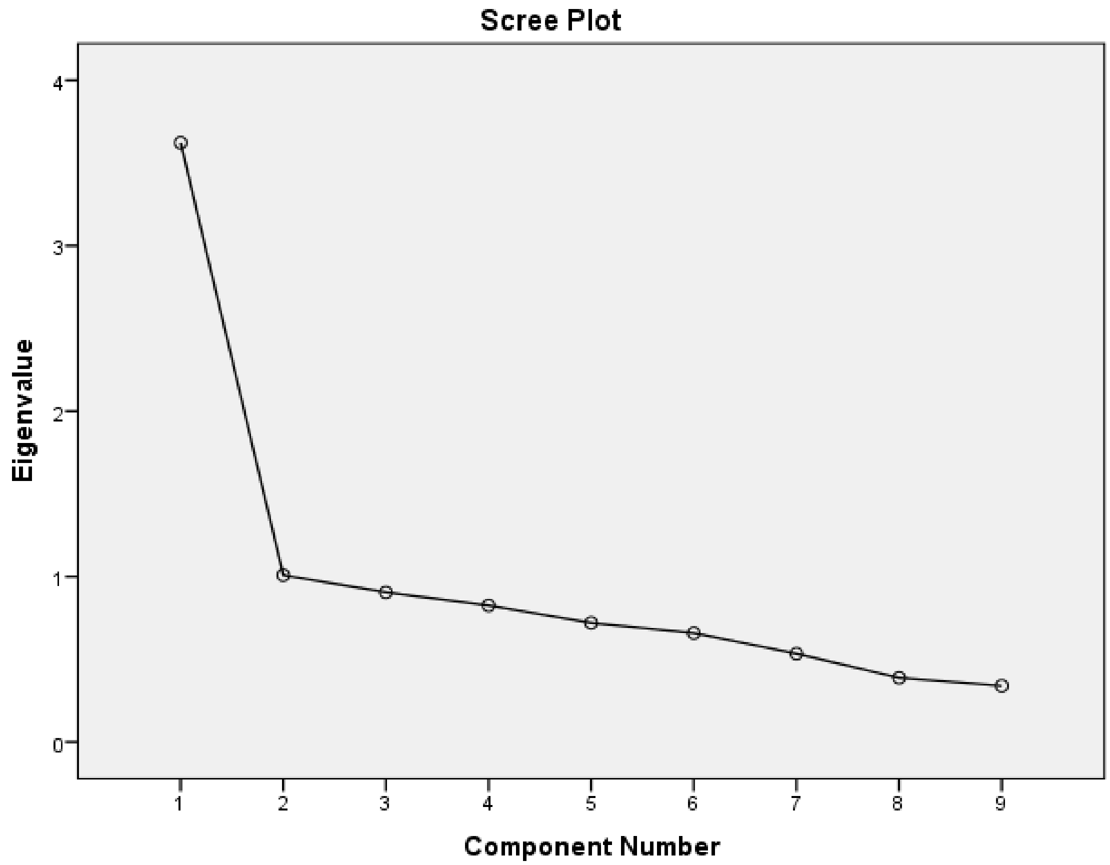


Figure 5:18 Screeplot for the Accessibility-Availability Cluster

The two-component solution explained 51.45% of the variance, with the Accessibility component contributing 40.25%, and Availability component contributing 11.20% of the variance. A direct oblimin rotation was performed revealing the presence of a simple structure with both component showing a number of attributes strongly loading on each component (Figure 5:19).

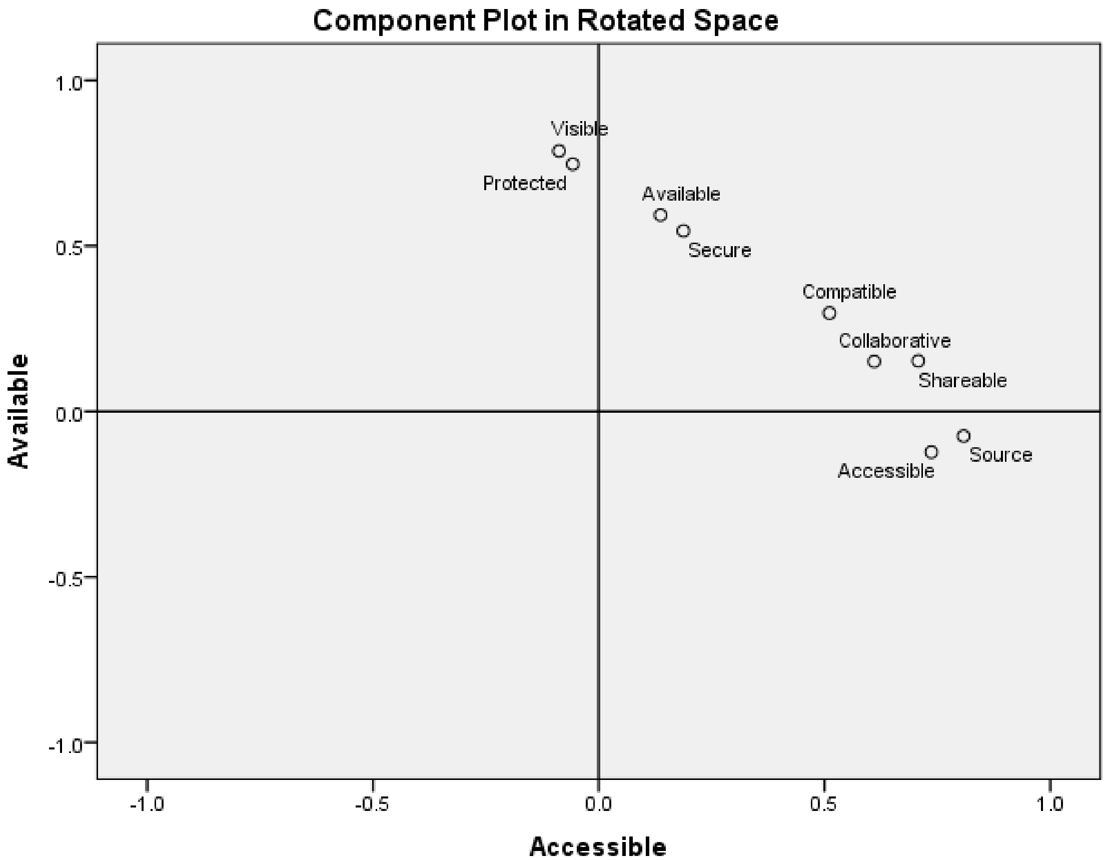


Figure 5:19 Component Plot in Rotated Space for Accessibility-Availability IQ Dimensions

5.6.2.C Operational (Effectiveness-Robustness) Category

The information quality attributes making up the operational category refers to the extent the information satisfy or enable effectiveness of the task being performed. For the Operational (Effectiveness-Robustness) category, the inspection of the screeplot revealed an inflexion after the second component supporting the decision to retain two components for further investigation (Figure 5:20).

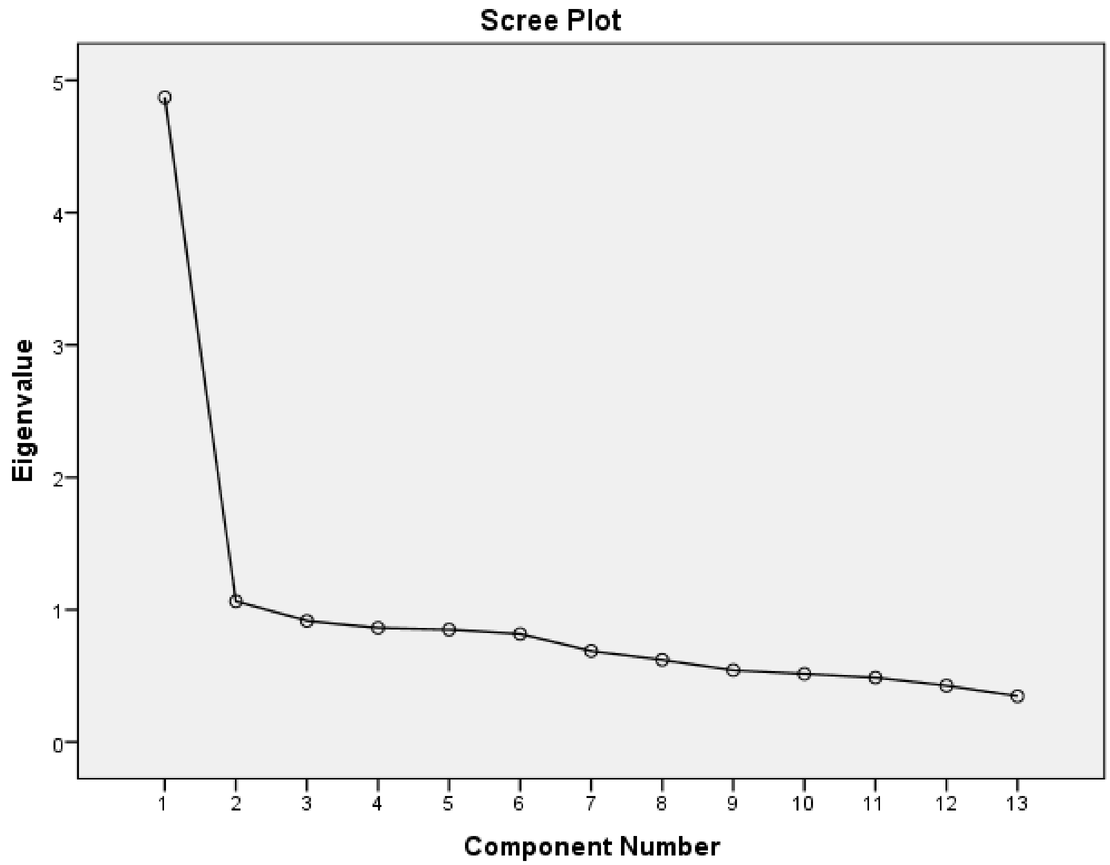


Figure 5:20 Screeplot for the Effectiveness-Robustness Cluster

The two-component solution explained 45.65% of the variance, with the Effectiveness component contributing 37.47%, and Robustness component contributing 8.178% of the variance. A direct oblimin rotation was performed revealing the presence of a simple structure with both component showing a number of attributes strongly loading on each component (Figure 5:21).

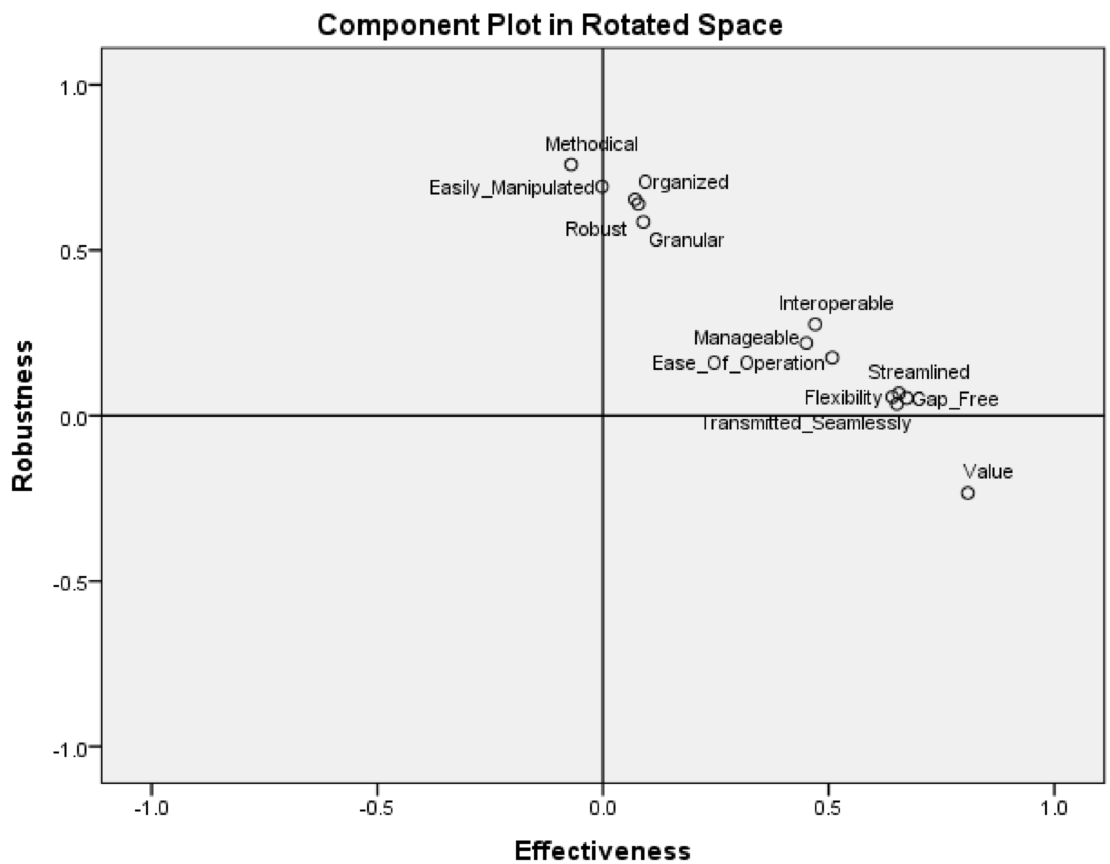


Figure 5:21 Component Plot in Rotated Space for Effectiveness-Robustness IQ Dimensions

5.6.2.D Usable (Content-Scope) Category

The quality attribute of this category refers to properties that are task dependent that sufficiently enables and supports the user of the information in decision making relevant to the task. For the Usable (Content-Scope) category, the inspection of the screeplot revealed an inflexion after the second component supporting the decision to retain two components for further investigation (Figure 5:22).

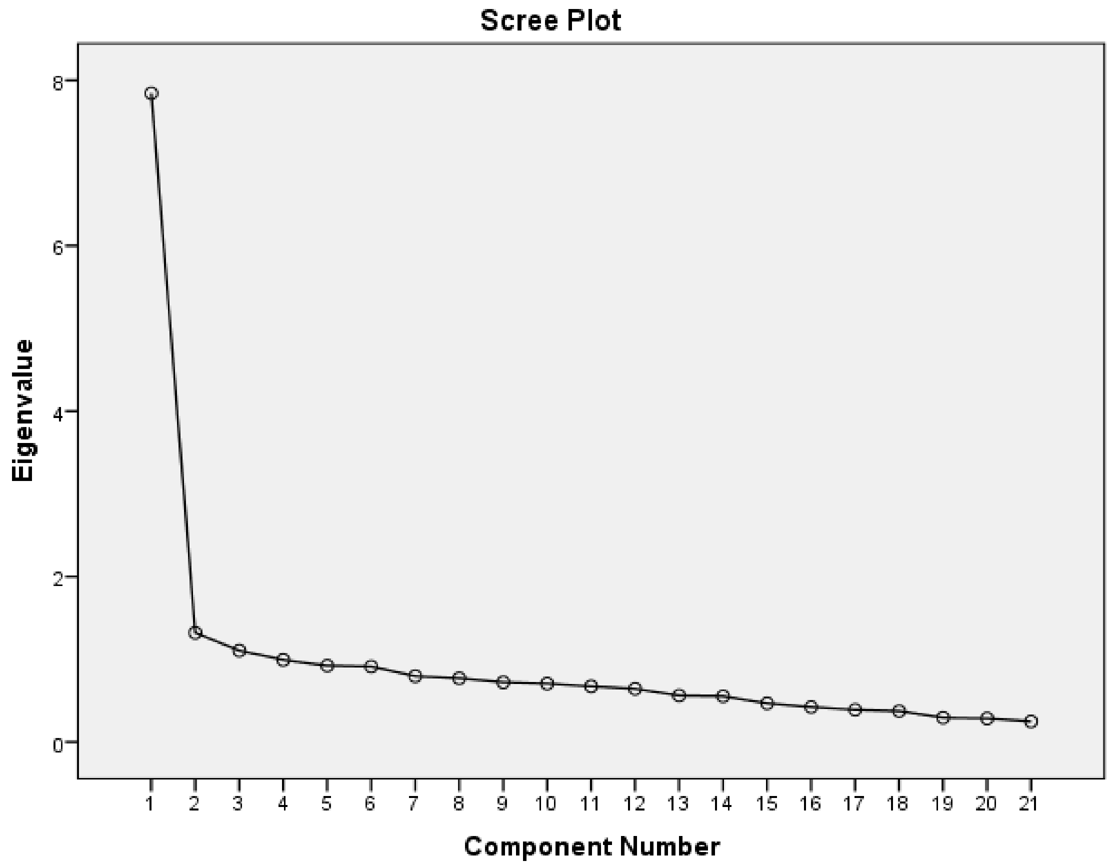


Figure 5:22 Screeplot for the Content-Scope Cluster

The two-component solution explained 43.64% of the variance, with the Content component contributing 37.35%, and Scope component contributing 6.29% of the variance. A direct oblimin rotation was performed revealing the presence of a simple structure with both component showing a number of attributes strongly loading on each component (Figure 5:23).

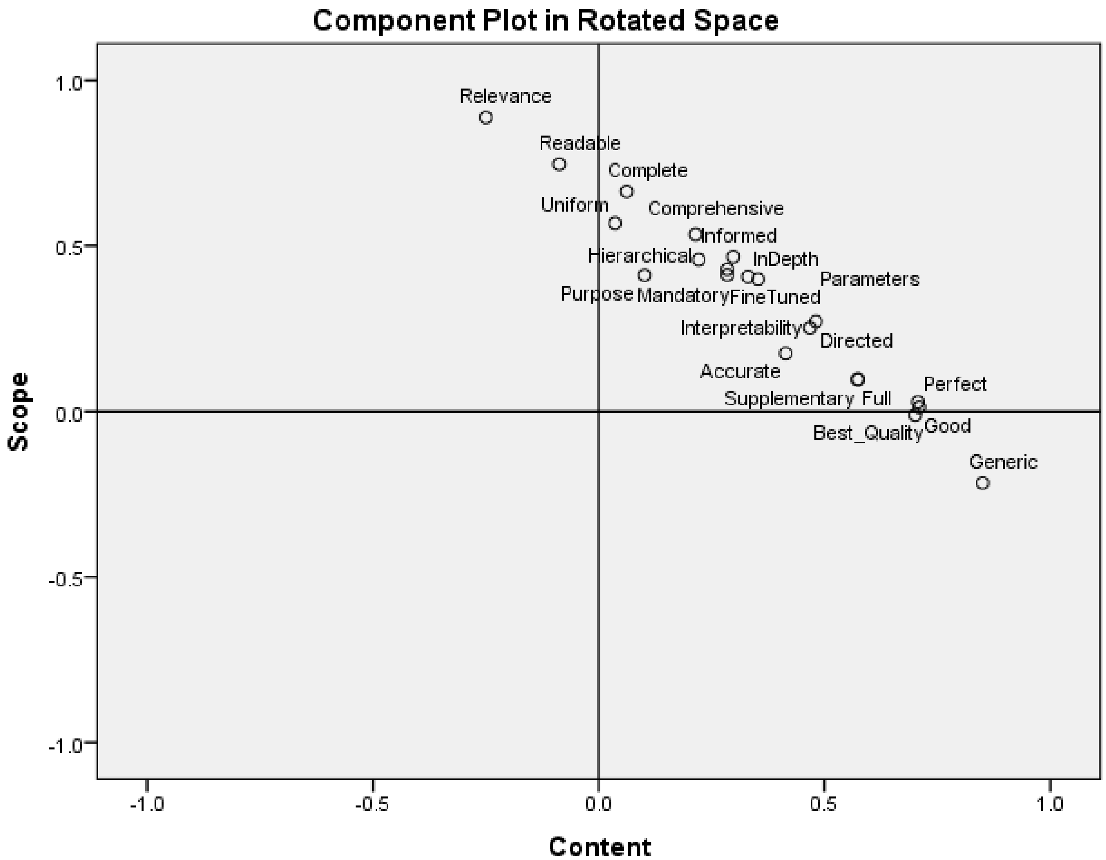


Figure 5:23 Component Plot in Rotated Space for Content-Scope IQ Dimensions

5.6.2.E Aesthetic (Visualisation-Form) Category

The aesthetic quality attribute of this category refers to the visual representation of the information within the operational context that may assist in providing clarity in understanding the information provided such as charts, diagrams, or pictures. For the Aesthetic (Visualisation-Form) category, the inspection of the screeplot revealed an inflexion after the second component supporting the decision to retain two components for further investigation (Figure 5:24).

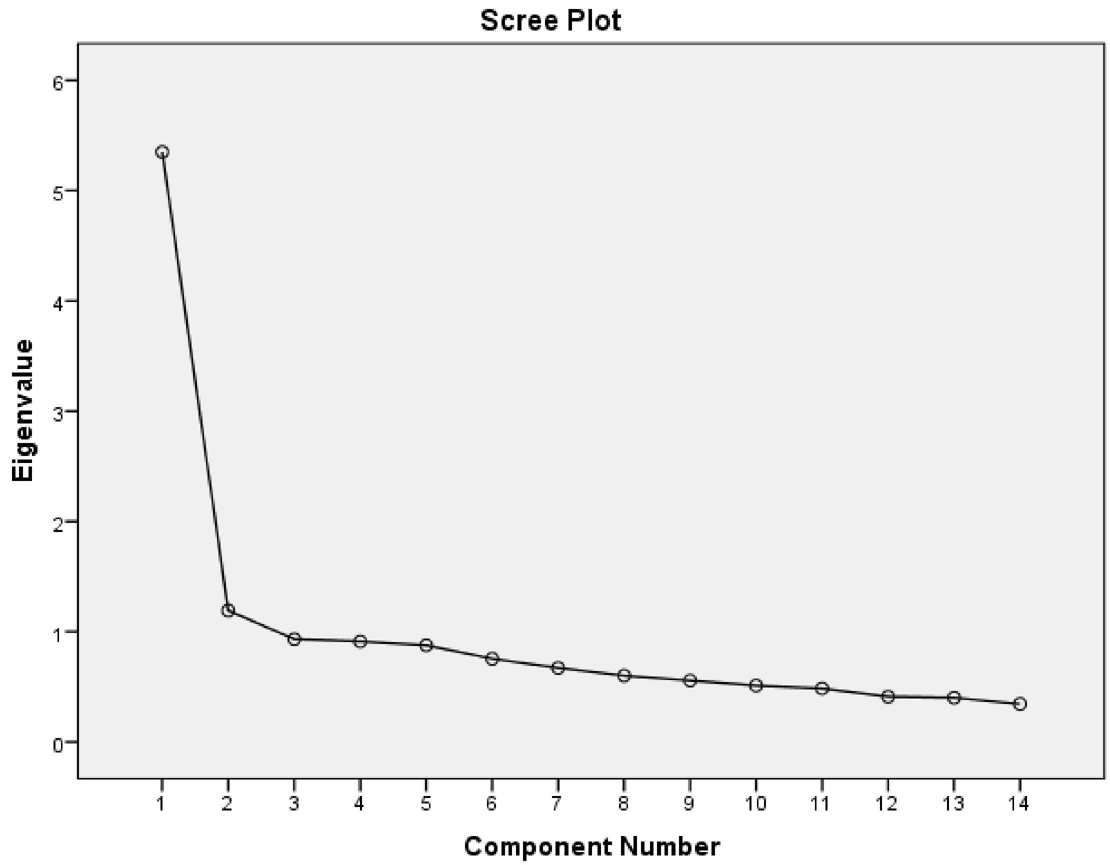


Figure 5:24 Screeplot for the Visualisation-Form Cluster

The two-component solution explained 46.73% of the variance, with the Visualisation component contributing 38.22%, and Form component contributing 8.51% of the variance. A direct oblimin rotation was performed revealing the presence of a simple structure with both component showing a number of attributes strongly loading on each component (Figure 5:25).

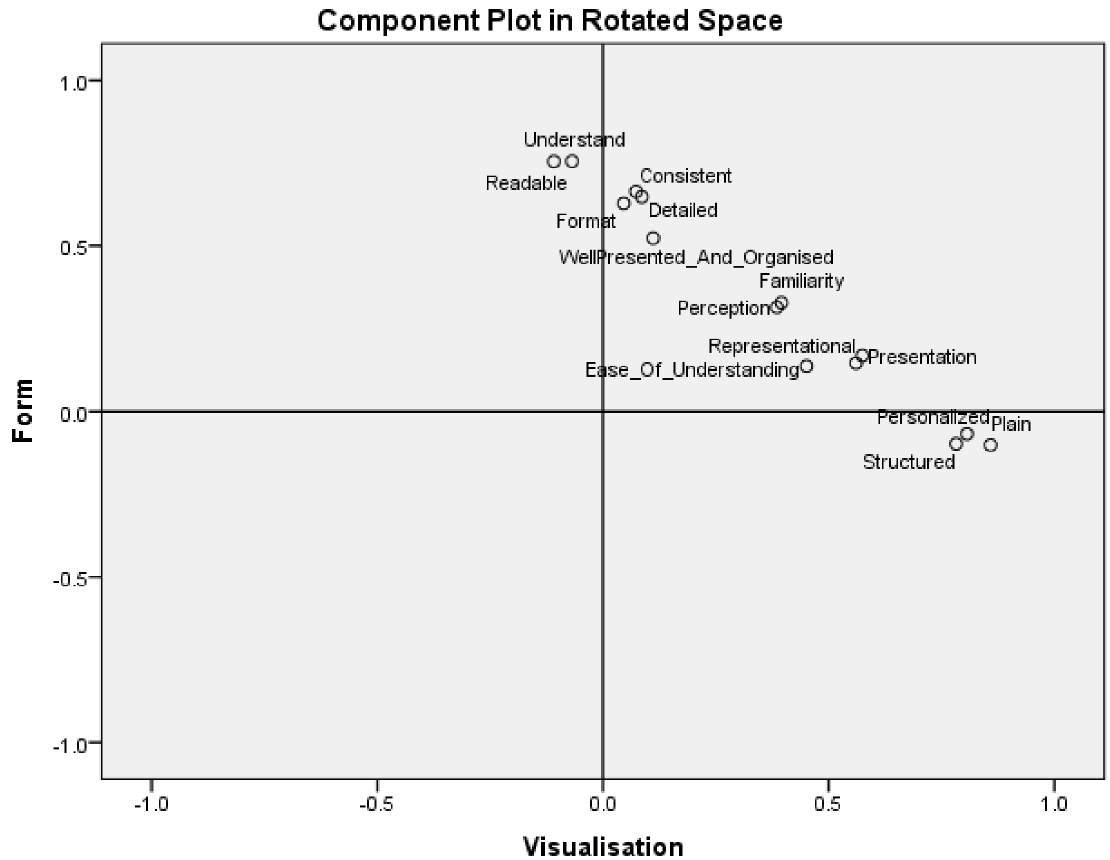


Figure 5:25 Component Plot in Rotated Space for Visualisation-Form IQ Dimensions

5.6.2.F Currency (Time) and Volume (Volume) Category

The currency (time) and volume (volume) quality attribute refers to how current and how much information is required within the operational context. The attributes are synonymous to volume and velocity attribute of big data (Birke, Bjoerkqvist, Chen, Smirni, & Engbersen, 2014; Chardonnens, Cudre-Mauroux, Grund, & Perroud, 2013; Laney, 2001). For the Currency (Time), Volume (Volume) category, only one component was extracted for each respectively. Hence, the component plots were not produced. These components explained 44.24% and 44.70% of the variance respectively. Further inspection of the screeplot justified the retention of the single components as the point of inflexion occurred after the first component (Figure 5:26 and Figure 5:27).

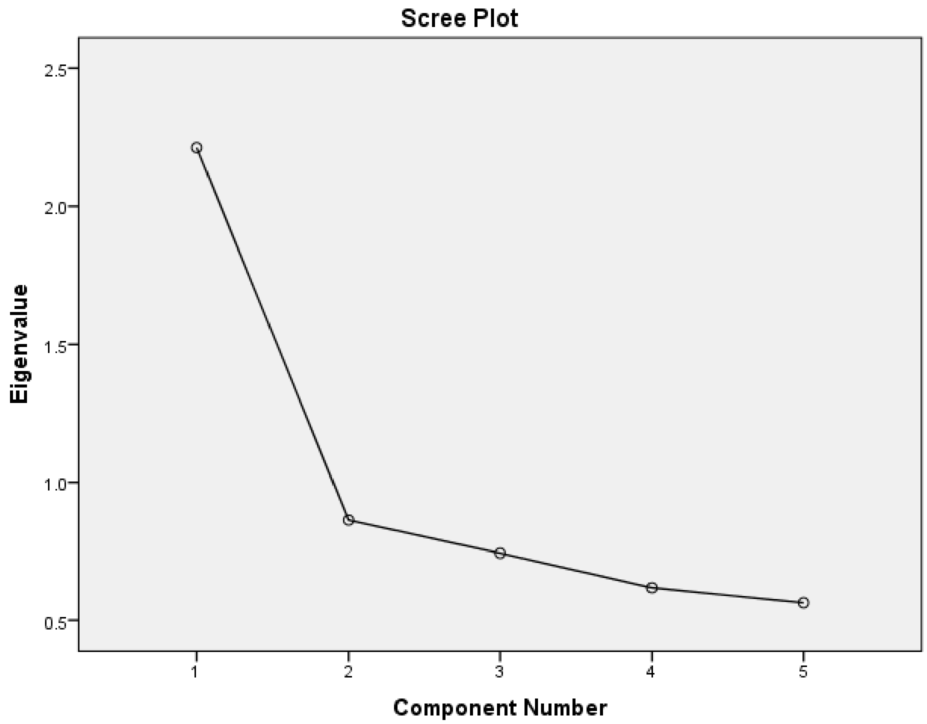


Figure 5:26 Screeplot for the Time Cluster

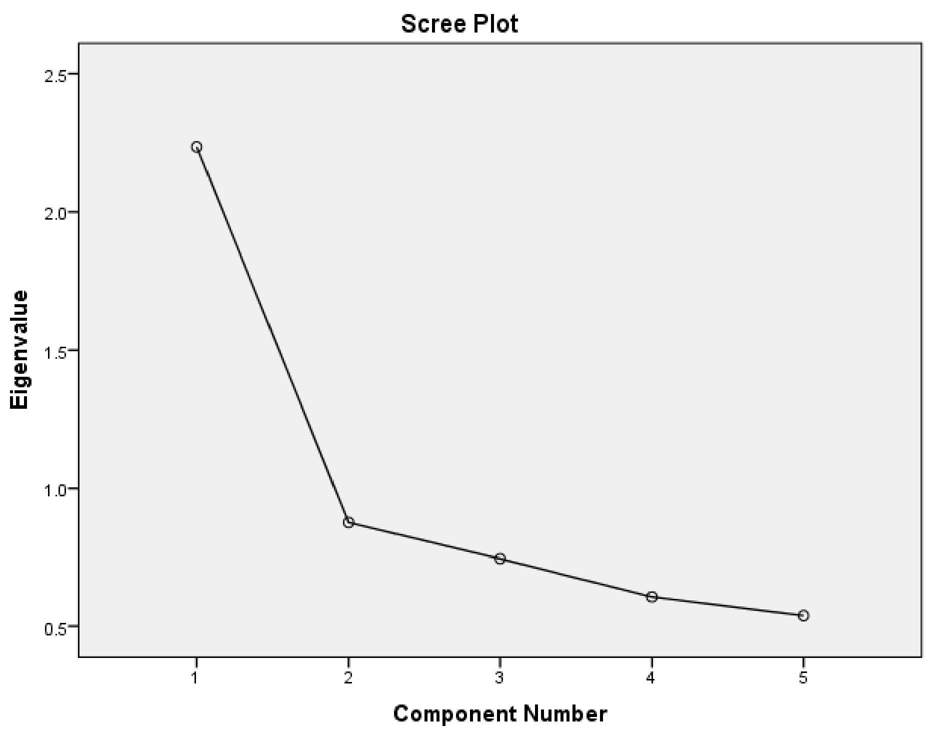


Figure 5:27 Screeplot for the Volume Cluster

A final test, Cronbach's alpha coefficient test, was conducted to determine the validity of the questionnaire scale (J. Pallant, 2013). The Cronbach's alpha test (α) conducted on the variables attributed to the 12 IQ dimensions produced values ranging between .656 and .867 which is within the optimal range of .6 and .8 (Table 5:36), and suggests very good internal consistency and reliability for the scale used in determining the IQ dimensions from the sample (Field, 2013; J. Pallant, 2013).

Table 5:36 Reliability Statistics of IQ Dimensions

IQ Dimension	Cronbach's Alpha (α)	Cronbach's Alpha (α) Based On Standardized Items	No Of Items
Reputation	.805	.806	7
Validity	.767	.768	7
Available	.764	.769	5
Accessibility	.656	.658	4
Effectiveness	.813	.813	8
Robustness	.731	.731	5
Content	.866	.868	11
Scope	.867	.869	12
Visualisation	.826	.825	8
Form	.809	.810	8
Time	.679	.683	5
Volume	.687	.690	5

5.7 Chapter Summary

It has been reported that information quality is a prevailing issue in many organisation (Batini et al., 2009; Jylhä & Suvanto, 2015; Redman, 1998; Sebastian-Coleman, 2013). With specific reference to FM industry, an issue facing FM organisations involved with AM is the inability to assess effectively the quality of information being generated within its operations and the impact this has on AM programs (S. Lin et al., 2006; Sebastian-Coleman, 2013). In the field of facility management (FM), Jylhä & Suvanto, (2015) noted that poor information quality results in waste. It has been noted that improving the quality of information in business can yield significant benefits to an organisation's overall efficiency, competitiveness and responsiveness (Chaffey & Wood, 2005; Jylhä & Suvanto, 2015). However, research investigations do not provide an empirical basis for the prevalence of information quality issue in organisations. In order to resolve these problem, there is a need to investigate those latent factors that constitute the quality of information in AM activities (S. Lin et al., 2006; Too, 2010a).

This chapter sets out to determine, empirically, the prevalence of information quality issues in AM programs within the context of facilities management industry, which specifically answered the second research objective (see chapter 1). Based on this investigation, data was collected using a random sampling technique from organisation engaged in AM within the field of FM. The sample was drawn from a sample frame that was obtained from the list of businesses organised by BvD Fame, (2013) having SIC code of 81100 - Combined facilities support activities.

A sample size of 363 was determined from the sample frame and was deemed relevant for the study. Data was collected using a structured questionnaire distributed to the identified organisations in the sample. A response rate of 42.22% was achieved, which was deemed good. The questionnaire was divided into three section in order to collect information about the characteristics of the participants, the characteristics of the organisation, and the prevalence of information quality. The collected data was analysed using the statistical software program - SPSS ver 22 software. The analyses conducted were demographic data analysis, organisation data analysis, and information quality data analysis.

The results from the analysis presented a unique insight into the nature of the FM industry. Based on the demographic data, it was observed that men predominated the FM industry but the difference between the male and female groups were marginally small. In addition, the male group were characteristically younger while the female group were characteristically older. With reference to education and years of experience, it was observed that most respondents had a qualification equivalent to Level-7 with 6-10 years of experience.

The organisational data analysis examined the structure of FM organisation within the sample. The variables considered in this analysis were size and hierarchical level. Based on this, the organisation was classified into micro, small, medium, and large size with hierarchical level of strategic, tactical, and operational. It was seen that FM organisation were predominantly medium in size whereby the tactical level was the dominant level. This suggests a shift from the operational nature of FM towards a strategic nature.

The most significant part of the analysis was the determination of the prevalence of information quality in AM programs. This analysis was able to show the prevalence of information quality in FM organisation as well as determining if the size or the structure of the organisation had a main effect on the quality of information. Based on this analysis, there was a high prevalence if information quality issue with a mean score of 7.89 and median score of eight. It was also observed that the score was distributed normally within the sample having a standard deviation score of 1.467 at 95% confidence level.

Further tests were carried out to determine if the size or structure of the organisation had an effect on information quality. These were based on a series of analysis of variance tests (ANOVA) which include a one-way ANOVA and a Factorial ANOVA (Two-way between groups ANOVA). The results from these tests demonstrated that the structure of the organisation had a significant effect on the quality of information, while the size of the organisation did not have any significant effect on the quality of the organisation which was in contrast to the result of Haug et al., (2013). However, it was noted that the size of the organisation acted as a moderating factor on the structure of the organisation.

Based on this analysis, micro size organisation had a simple structure with just two levels, but it was noted that information quality issue was very high at the strategic level (Figure 5:28). As seen in Figure 5:28, the operational level experienced low levels of information quality issues across the different size organisation. However, information quality issues had similar levels of prevalence at the tactical and strategic levels for the small, medium, and large. In essence, this indicates that as the size of the organisation grows; its structural elaboration becomes more complex (i.e. having several layers) which in turn has an effect on the quality of information.

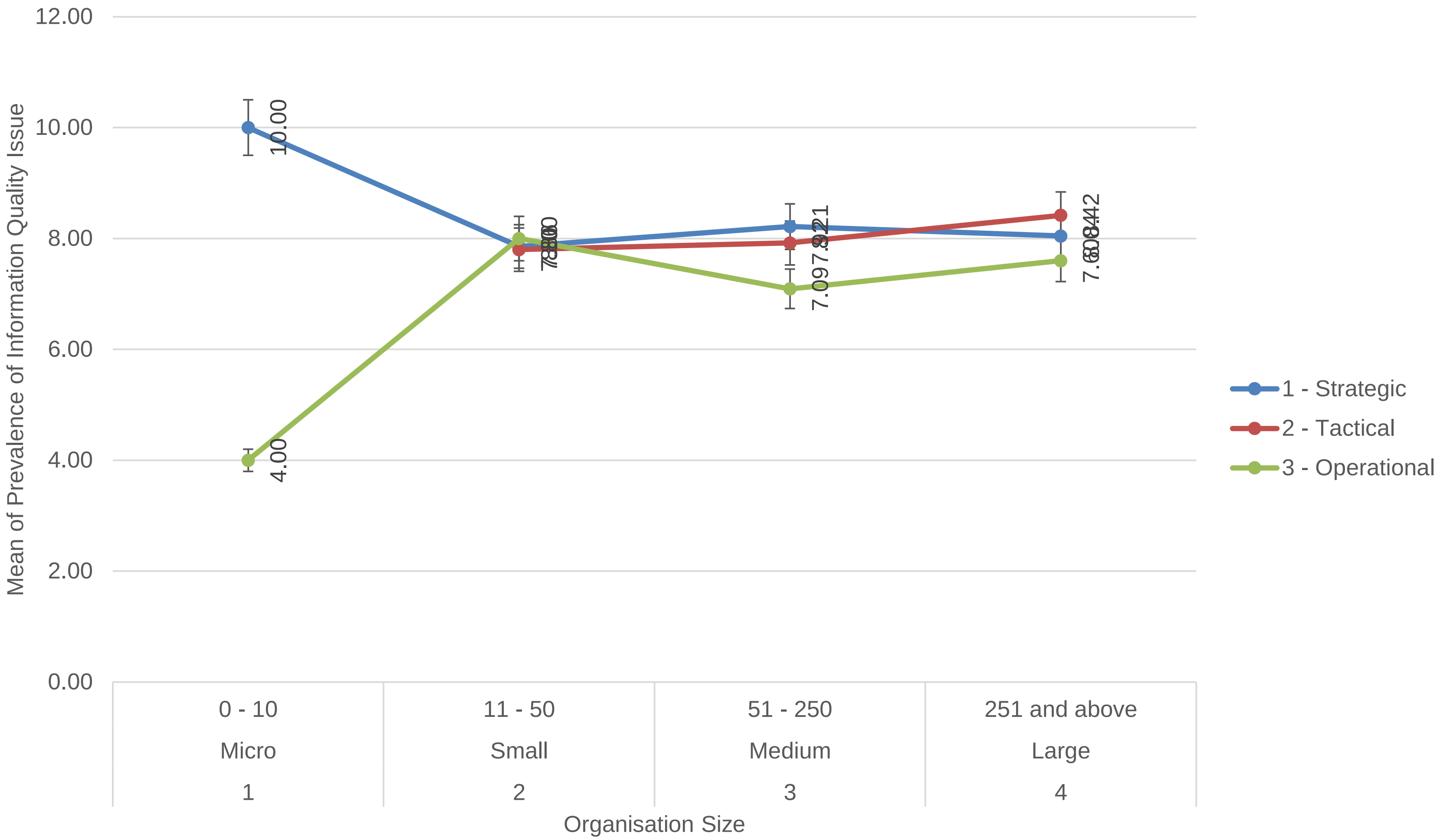


Figure 5:28 Effect of Organization Structure on Prevalence of IQ Issue with Size acting as a Moderator (n = 142, Confidence Level = 95%)

This chapter further presented the analysis of IQ dimensions within the context of AM. It provided an empirical basis for identifying the dimensions of IQ that approximate real-world context of AM, which constitutes the attributes identified from the interview analysis and extant literature.

A quantitative approach was used in determining the IQ dimensions. It was noted that there are more dimensions of IQ than as previously indicated from the literature, whereby the identified IQ dimensions based on the analysis closely approximate the real-world context. The analysis in this study yielded 12 IQ dimensions using Principal Component Analysis with Direct Oblimin Rotation. These dimensions specifically indicate which IQ attributes account for each IQ dimension (Figure 5:29). For instance, it was observed that the dimension “Volume” constitute the following IQ attributes; *Adequate, Appropriate Amount, Sufficient, Enough, Little,* while the “Scope” dimension constitute the following attributes; *Readable, Complete, Uniform, Comprehensive, Informed, Hierarchical, Mandatory, Fine-Tuned, Purpose, In-Depth, Parameters.*

An appropriate naming convention was formulated to provide relevant terms to the identified groups of dimension derived from PCA. The challenge of naming of IQ dimension has been acknowledged in studies of information quality. Thus, to ensure that the naming used in this study reflected the perspective of the operations, a contextual naming convention was instituted. This naming convention embedded the semantic meaning of the identified dimension within the operational context. Based on the analysis, it was concluded that the IQ dimensions are latent constructs, which are accounted for and can be determined from measurable IQ attributes (see chapter 4) which are constructed by the actors within the social context. These latent constructs can be explored using sound empirical methods such as that presented in this study. This technique provides a sound empirical foundation based on rigorous scientific principles. As such, the identified dimension in this study can be argued to approximate the real-world context as well as serving a basis for identifying the dimensions of IQ that can be used for further analysis.

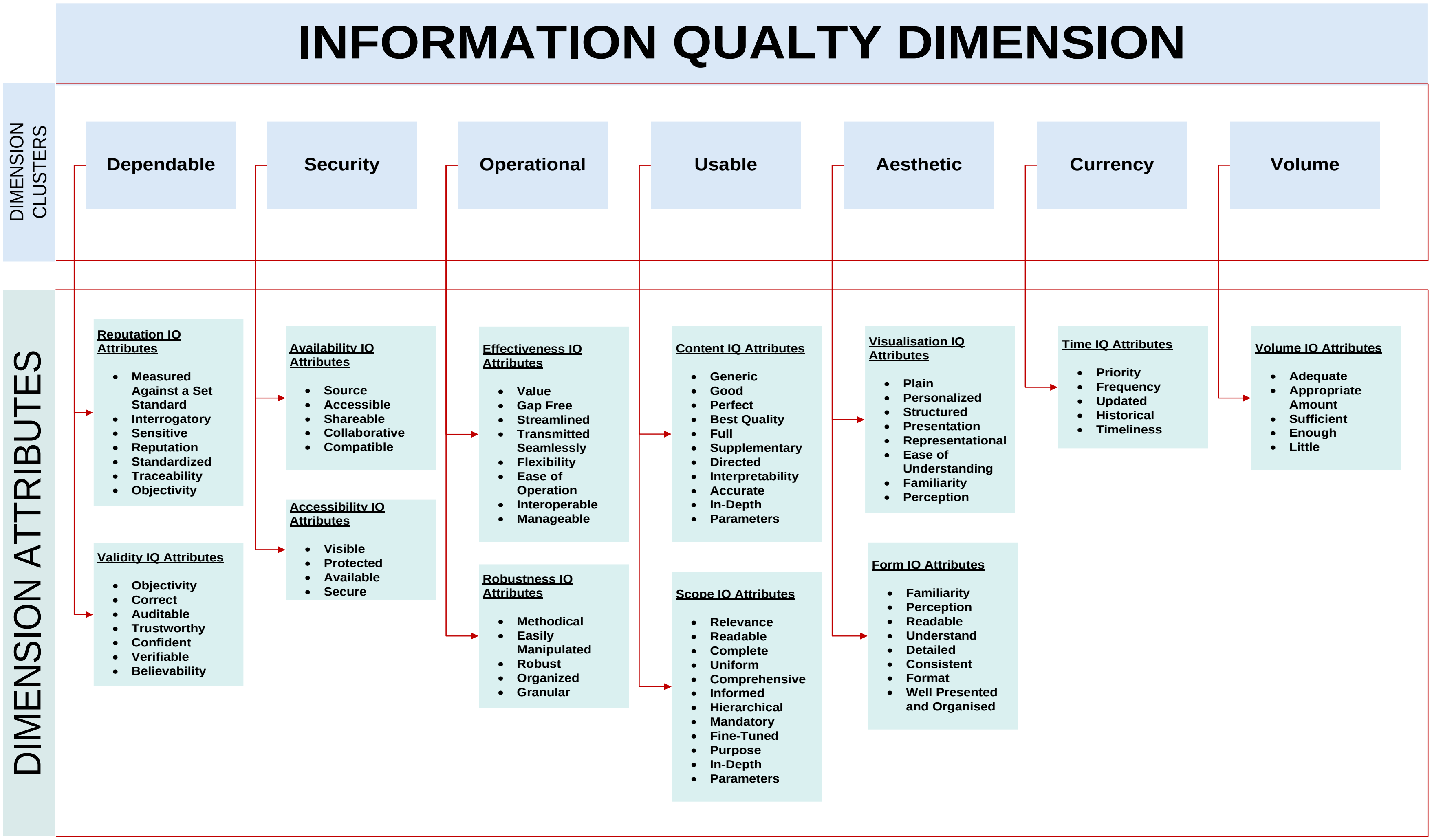


Figure 5:29 AM Information Quality Dimension Framework

Chapter 6 Discussion and Framework Development

This chapter presents a discussion of the key findings from the result of the analysis conducted based on the research aim and objectives (see section 1.2.1 and 1.2.2). The findings are drawn from the key stages of the research: literature review, qualitative analysis and the quantitative analysis. The chapter begins with a discussion of the findings from the literature, then by finding from the qualitative analysis, and finally the findings from the quantitative analysis. It must be noted that the methodology adopted in this research (see Chapter 3) acts as an influence on the discussion approach for each key stage of the research. Also, it should be noted here on that many of the key points arising from the analysis have already been covered within the body of the analysis itself (Chapter 4 and Chapter 5). Creswell, (2014) indicated that it is usual to discuss the findings of the data analysis within the result as a comprehensive process. For this reason, the overall discussion chapter will focus only on the main observation from each analysis. The findings will be discussed and contextualised with reference to various literature drawn from the body of work presented in the literature review and otherwise. The chapter concludes with the development of the framework followed on by the validation of the developed framework.

As mentioned earlier, the discussion is influenced by the research methodology – inductive mixed methodology – adopted for this study. This method incorporates the use of qualitative and quantitative methods in a sequential manner to explore and explain the phenomenon in depth. This process is known as an exploratory sequential mixed method where the researcher begins with a qualitative research phase to study the views of the participants and collate data which is subsequently analysed, of which the results is built into a second quantitative phase. This approach allows the research to fine-tune the study by specifying the variables that need investigating and required to develop the instruments that best fits the sample under study.

6.1 Review of Concepts

The following concepts have been presented and discussed in the thesis: facilities management (FM), asset management (AM), and information quality (IQ). Based on evidence from the literature review, there is a difference between facilities management (FM) and asset management (AM). It has been noted that AM is a strategic function that resided within FM and can exist as an independent function. FM, as a discipline, focuses on integrating people, place, technology, and processes. In addition to this, FM acts as an intermediary that translates the functions required to satisfy external stakeholders. From this, it was seen that the quality of information (IQ) had an effect on the delivery of AM programs undertaken by FM. Also, it was noted that IQ is a multi-dimensional concept, which is influenced by many factors. These factors were observed to cause problems in IQ within organisations operations. As such, several techniques have been adopted to aid in assessing and improving IQ. However, such techniques were noticed to possess several limitations such as the inability to implement them, an absence of a theoretical basis, and the complexity in understanding them. Because of these limitations, this study sought to provide an alternative approach to resolving the identified challenges. Thus, the subsequent section presents the discussion of the key findings from the literature review and analysis that attempts to resolve these issues.

6.1.1 Findings from Literature Review

The literature review findings are summarised below. Each finding relates to a research objective whereby the heading provides the context of each objective. The heading also includes a suffix identifier to aid in referencing the appropriate research objective (see Table 1:1, Chapter 1).

6.1.1.A Factors Influencing Asset Management Information Quality (RO1)

Evidence from the literature review indicates that numerous factor bear on the quality of information in AM programs undertaken in FM. These factors have been categorised under the major category of information technology, organisational, and people. Table 6:1 presents a summary of the factors considered within the literature to affect information quality. However, these factors considered by the authors failed to recognise the effect of the structure of the organisation and its influence on the quality of information (IQ). This presents a significant limitation on the facts presented in their arguments. However, the structure of organisation and its size have been considered by other authors to have an influence on the quality of information (Jordan, 1994; Jordan & Tricker, 1995; Mintzberg, 1979; WILLMER, 1977). The effect IQ has on organisations have also been described by Redman, (1998) and Haug et al., (2013). These include business users, customer and customer satisfaction, increased operation costs, inefficient decision-making, lowered employee job satisfaction, organisation culture, trust and acceptance. As an addendum, Redman, (1998) posited that the quality of information exacerbates the problems at the strategic, tactical, and operational levels of the organisation in unique ways.

Table 6:1 Summary of Factors Influencing Information Quality

Perspective	Factor	Author
Information Technology	Lack of IT systems for data management	Haug et al., (2013)
	Lack of possibilities for input in existing IT systems	
	Poor usability of IT systems	
	System Integration	Lin et al., (2006)
	Data Access	
	Database Synchronization	
	Data Exchange	
	Data Collection Process	
	Coding of Information	
	Information Technology	
	Extraction of Data	
Organisational	Organizational Readiness and Business Process Reengineering	Lin et al., (2006)
	Management Commitment	
	Lack of Codified Business Standard	
	Disconnect between Business and IT	
	Lack of written information quality policies and procedures	Haug et al., (2013)
	Lack of clarity of roles in relation to data creation, use and maintenance	
	Inefficient organisational procedures	
	Lack of management focus on relation to information quality	
	Lack of information quality measurement	
People	Training	Lin et al., (2006)
	Data Recording	
	Communication and Management Feedback	
	Missing placement of responsibilities for specific types of data	Haug et al., (2013)
	Lack of reward/reprimand in relation to information quality	
	Lack of training and education of data users	
	Lack of emphasis on the importance of information quality from managers	

6.1.1.B Information Quality Attributes Specific to Asset Management in Facilities Management Operations (RO3)

As indicated within the literature, there is no general agreement to the dimensions of IQ (Batini et al., 2009; S. Lin et al., 2006; Sebastian-Coleman, 2013; Wand & Wang, 1996). This problem is further exacerbated by lack of research in the field of FM as limited research has been conducted within the discipline to define the IQ attributes specific to its operation. An attempt made by Jylhä & Suvanto, (2015) utilised attributes already identified from previous studies in other fields specifically from the seminal work of R. W. Wang et al., (1996). However, it did not succeed in classifying IQ attributes specific to FM.

R. W. Wang et al., (1996) defined IQ dimensions as a set of IQ attributes that represents a single aspect or construct of IQ. Sebastian-Coleman, (2013) defines IQ dimension as aspects of data through which its quality can be measured and quantified. Koronios et al. (2005) argues that the depiction of IQ from the perspective of accuracy provides a limited contextualization of the issues in IQ. Lin et al., (2007) suggested that IQ should be defined beyond accuracy and encompassing multiple dimensions.

A typical understanding of IQ is information fit for use by the information consumer. This simplistic definition provides a crucial foundation for the understanding of IQ. In determining the dimensions of the quality of information in AM programs undertaken by FM, a contextual view was established. This view took into account the type of information the operations or activities performed by the information consumer. By so doing, a vivid and explainable construct of IQ dimension was determined for further assessment. A comprehensive list of IQ attributes identified from the literature and used in this study is presented in Appendix IX

6.1.2 Findings from Qualitative Analysis

Following on from the literature review, the first phase of the research was the qualitative analysis aimed at achieving the following research objectives respectively (See Section 1.2.3 Chapter 1):

1. To examine what factors influence asset management information quality in facilities management (RO1)
2. To identify the information quality attributes specific to asset management in facilities management operations (RO3)

The adopted method of analysis was inductive thematic analysis (see Section 3.5.5 Chapter 3). This was used to identify the specific themes associated with the research objectives. Non-probabilistic sampling was used to enable the selection of information-rich cases from FM organisation for in-depth study. Respondents for this research were staff of the organisation at the strategic, tactical, and operational levels which included managers and front line staff. Nine respondents in total from the contacted organisations agreed to take part in the research after consents concerning the research was agreed. Relevant data was collected on-site via a semi-structured interview. A participant coding scheme was also developed to facilitate the analysis of the responses of the participants and ensure anonymity was fully established. The findings from the qualitative analysis are summarised below. Each finding relates to a research objective whereby the heading provides the context of each objective. The heading also includes a suffix identifier to aid in referencing the appropriate research objective (see Table 1:1, Chapter 1)

6.1.2.A Factors Influencing Asset Management Information Quality in Facilities Management (RO1)

The investigation of the factors influencing IQ of AM programs in FM operations was classified into three (3) domains:

1. The information domain
2. The organisation domain
3. The people domain

Based on this classification, several themes including subthemes, were identified which reflects the opinions of the respondents in relation to the questions being asked. The findings from each of these domains is discussed in the following sub-sections.

A.1 The Information Domain

The information domain constitutes factors that influences the quality of information from an information management perspective. Lin et al., (2006) considered this a technological factors. However, this form of consideration raises further issues in explaining the context as is excludes the interaction of the human element. As such, a more appropriate term used in this research is information management as this encapsulates the human element.

Evidence from the research indicated that several issues exists concerning the information domain but due to word constraints only, the very significant issues will be discussed. It was observed that under the information domain, the theme “barrier to quality asset information” had the highest number of references (34.55%) made concerning this issue (Appendix III). Under this theme, it was noted that access to data, information handover processes, no comprehensive asset registers, organisation not understanding their assets, and the volume and rate of change of asset data constituted a significant barrier to quality asset information. This issues corroborates the literature as challenges faced in FM when managing critical asset information (Baškarada & Koronios, 2014; Champy, 2002; Kristine K. Fallon & Palmer, 2006; French, 1994; NHS Estates, 2003; RICS, 2013). For instance asset registers vary and are not always in a user-friendly form for non-specialist (NHS Estates, 2003), asset information usability is often low specifically at building handover and commencement of FM operations (Dibley, 2011), and handover is difficult as different information formats used in information delivery and operations differ greatly while key people leave before project completion (Kristine K. Fallon & Palmer, 2006; Whyte et al., 2012).

Following on from the barrier to quality asset information sub-theme, information systems configuration with 28.18% references possessed the second highest issue. Information system configuration refers to the constellation of conceptually distinct elements that commonly occur together and form an integrative whole (Lyytinen & Damsgaard, 2011). Such constellation affects the storage, flow, and control of information as organisations make information system changes in order to implement new and updated hardware and software components, correct software flaws and other errors (Radack, 2011). Radack, (2011) acknowledged that such constant changes result in adjustments being made to the configuration of information systems which further impacts operations. Based on this, the following sub-themes were identified as critical in information system configuration that affect the quality of information used in AM: central repository, information flow, and information system controls. Having a central repository was seen as a valuable resource to information management and control as indicated by ENVADV-6:

> *"…within [the organisation] we have what we call an integrated management system. It has all the paperwork we need in order to do our jobs properly…"*

However several authors contrasted the use of central repositories in the industry as not usually a viable option due to: (1) the fragmented nature and adversarial behaviour that characterizes the industry and (2) the lack of central repository as a challenge to fully address the need for asset planning (Shen et al., 2012; VANIER, 2000). This evidence was supported by interviewees BDMGR-5 and ND-7.

A.2 The Organisational Domain

The organisation domain constitutes factors that influences the quality of information from an organisational perspective. Under the organisation domain, the theme "Organisational Processes" had the highest number of references made to it (50.67%) followed on Asset Management Processes with 26.67% references. As indicated from the previous section, only these two will be discussed as they had the strongest influence as indicated by the respondents in the research.

The following subthemes were identified under the organisational processes: accountability and auditing, management support structure, and establishing standard processes. Providing more accountability and maintaining audit trails enables established processes achieve their potential (Al-Mashari, 2001), but this has often been viewed as low priority by FM managers (Amaratunga, Haigh, et al., 2002) which supports the findings from the responses within the research. Asset Management Processes with 26.67% references constituted asset lifecycle analysis and asset management framework awareness. The lifecycle and asset management framework involves several interdependent stages including the identification of the need, the definition of the requirements, and total management of assets (S. Lin et al., 2007). However, this is an information intensive activity of which quality is paramount.

A.3 The People Domain

The people domain focuses on the concerns of staff and operators which include issues of job description, job security, motivation, education and training, and psychological needs. Three themes were expressed in the people domain which include development, behaviour, and skills with values of 41.61%, 37.50%, and 20.83% respectively. In essence, the magnitude of these values suggested the level of concerns associated with these themes and their impact on IQ as expressed by the participants undertaking AM activities in FM. For instance, under the “development” theme having 41.61%, training was considered to be relevant to influencing the quality of information used. In the literature, it was also observed that training was crucial in information quality improvement (Batini et al., 2009; Batini & Scannapieco, 2006; Haug et al., 2013; S. Lin et al., 2006; Sebastian-Coleman, 2013). For instance Sebastian-Coleman, (2013) cites that effective use of information requires a support structure of employee and vendor training as information errors emanate from the point of entry into an organisation from external vendors, partners, or customers or information consumers misunderstand the information and do not know how to use it. This view has been reported in the analysis by respondents PLNR-3 and TRSMGR-9.

Under the behaviour theme, it was noted that two (2) sub-themes as expressed by the research participants had an influence on the IQ used in the AM programs. These were pro-active engagement and self-esteem. According to the respondents, when operatives engages with the system proactively the results from the interaction of this significantly improves which in turn tends to encourage the quality of information. However, it was noted that self-esteem was an issue in the FM. Zuashkiani, Rahmandad, & Jardine, (2011) reported that due to entrenched cultural behaviours, managers find it difficult to move from a reactive to a proactive culture. This tended to inhibit the full engagement of staff thus countering the effects of pro-active engagement.

Finally, under the skills attribute theme, 33.33% of the respondents recognised having a "balanced skill base" (20.83% of responses) as a factor that influences IQ in AM programs within FM operations. People's skills and abilities to use the system efficiently are very critical in AM operations (S. Lin et al., 2007). According to S. Lin et al., (2007) a perfect system would not be able to produce high-quality information if people do not have the right skills and knowledge to control the system. The implementation of AM principles further requires agents to develop new skills to cope with the various challenges of effective infrastructure AM (Schraven et al., 2011). Such skills thus should not be limited to technical skills but include a mix of soft skills as well (Schraven et al., 2011; Woodhouse, 2003). Example of these include policy making skills, communication skills, effective decision-making skills, etc. Woodhouse, (2003) argues that such skills should not be the remit of top management but should be permeated throughout the hierarchy of the organisation.

6.1.2.B Information Quality Attributes Specific to Asset Management in Facilities Management Operations (RO3)

Qualitative data analysis was further performed to identify the IQ attributes associated with AM activities. Data was collected from the interviews and were coded based on a deductive and inductive coding scheme (Kulatunga et al., 2004). Deductive coding involved using predetermined IQ attributes identified from the literature review while the inductive coding allowed for categories to emerge from the interview transcript (Kulatunga et al., 2004). A total of 71 IQ attributes were identified from the analysis and was subjected to further analysis. The identified attributes that emerged closely approximated the attributes identified from the literature review. What was further identified from the studies were those attributes that were significant to AM undertaken by FM practitioners. These attributes were determined using frequency distribution, and based on the analysis, seven (7) attributes were identified to be important. It is suggested that these attributes as indicated by the respondents hold very significant values towards performing AM activities. It also goes to suggest that these are the most important attributes of IQ the respondents actually considered in their evaluation of information. In light of this, the analysis did not seek to determine the reason why these attributes were important in this context as it was not within the scope of this research.

6.1.3 Findings from Quantitative Analysis

Following on from the qualitative analysis is the quantitative analysis. This is premised on the research framework developed in Chapter 3 and forms the second phase of the data analysis. The variables used in the quantitative analysis have been deduced from the qualitative analysis and literature to test specific phenomenon that influence IQ in AM programs undertaken by FM professionals. The research objectives discussed in this section are as follows (See Chapter 1):

2. The prevalence of information quality issue and influence of organisation structure on asset information quality in facilities management industry (RO2)
3. The classification of information quality attributes into specific information quality dimensions within the context of asset management in facilities management industry (RO4)

6.1.3.A The Prevalence of Information Quality Issue and Influence of Organisation Size and Structure on Asset Information Quality in Facilities Management Industry (RO2)

The prevalence of IQ issue in AM programs undertaken by FM professionals have not thoroughly been investigated. As such there is limited evidence to state how common this issue is in FM. It has been noted that organisations lacking high-quality information encounter increased costs in operations (Popovic & Habjan, 2012). Also, Jylhä & Suvanto, (2015) showed the importance of analysing the quality of information within the context of FM as poor quality of information results in waste due to overload of work. They further stated that poor information causes faulty information processing thus changing the value of information to negative. To this end, the prevalence of IQ issue affecting AM program was investigated in this study.

From the result presented in Chapter 5 , it was concluded that there is a high prevalence of IQ issue affecting AM programs undertaken by FM organisations. Based on the distribution of data, 50% of the respondents reported IQ issues between the values of 7 and 9 (high levels) on the 9-Points Likert Scale. This provides an empirical evidence to support anecdotal claims to issues of IQ. It was further observed that most issues of IQ are normally distributed and fall within one standard deviation of the mean based on the analysis (see Section 5.5.1).

Though the prevalence of IQ in FM industry affecting AM programs have been established in this study, it warranted further investigation as to what results in this issue. Evidence from the qualitative data analysis presents several factors that precipitates the issue of poor IQ. However, on close examination of this factors, it was observed that they occur within the context of the organisation. For instance, information systems of use, processes-policies-procedures, and training for managing information depends on the complexity of the organisation structure which is layered into hierarchies i.e. strategic, tactical, and operational hierarchies (Mintzberg, 1979; Redman, 1998) . In turn, the structure of the organisation is determined by its size whereby the larger the size of the organisation, the more elaborate its structure (WILLMER, 1977). WILLMER, (1977) and Mintzberg, (1979) both argued that these identified phenomenon have a profound influence on the flow of information. However, there is limited empirical evidence from the literature to suggest if the structure or size of the organisation has an effect on IQ. The data analysis presented in this study examined this phenomenon and tested this using ANOVA (One-Way and Factorial ANOVA). Also, the mean and standard deviation for each group was calculated respectively (see Section 5.5.2 for detailed analysis). The results from the ANOVA tests demonstrated that the structure of the organisation had a statistically significant effect on the quality of information, while the size of the organisation did not have any significant effect on the quality of information in the organisation. It was also observed that the size of the organisation acted as a moderating factor on the structure of the organisation.

Based on this analysis, micro size organisation with a simple structure presented high levels of IQ issue at the strategic level. The operational level experienced low levels of

IQ issues across the different size organisation. IQ issues was observed to be more prevalent at the tactical and strategic levels for the small, medium, and large organisation. In essence, this indicates that as the size of the organisation grows, its structural elaboration becomes more complex (i.e. having several layers) which in turn has an effect on the quality of information.

6.1.3.B The Classification of Information Quality Attributes Into Specific Information Quality Dimensions within the Context of Asset Management in Facilities Management Industry (RO4)

The final part of the data analysis was the classification of the IQ attributes into specific dimensions of IQ. These dimensions are constructs whereby each attribute can be distinguished. Evidence from the literature indicated that there are no specific dimensions to IQ. Also, IQ dimensions which have been previously identified from the literature may have little value in AM programs (Alenezi et al., 2015; R. W. Wang et al., 1996). This is as a result of the contextual nature of IQ i.e. the identification or utilisation of specific quality attributes are specific to the context of the operation where the information is created and used. In addition to this IQ, dimensions are latent constructs, which constitute measurable attributes expressed within the context of an operation. As such, there are as many IQ attributes as there are actors. Those attributes of IQ are derivatives of the relationships that exist between social actors and their technical environment in FM organisations.

The result of the analysis provided an empirical basis for identifying IQ dimensions within the context of AM programs undertaken by FM organisations. These IQ dimensions identified are the latent constructs determined from the IQ attributes constructed by the actors within the social context i.e. the FM organisation. By using Principal Component Analysis (PCA) with Direct Oblimin Rotation, twelve (12) IQ dimensions were identified. These dimensions specifically indicate what IQ attributes account for each IQ dimension. For instance, it was observed that the dimension "Volume" constitute the following IQ attributes; Adequate, Appropriate Amount, Sufficient, Enough, Little, while the "Scope" dimension constitute the following attributes; Readable, Complete, Uniform, Comprehensive, Informed, Hierarchical, Mandatory, Fine-Tuned, Purpose, In-Depth, Parameters (see Figure 5:29 in Chapter 5). This goes to evidence that IQ dimensions are latent constructs accounted for by specific attributes. The next section of the discussion presents the development of the framework based on the outputs from the data analysis.

6.2 Framework Development

The goal of this research was to develop a framework that to be used in assessing IQ in AM (see Chapter 1). The justification for the development of the framework builds on the issues surrounding information quality (IQ). It was stated in the literature review that IQ is a multi-dimensional phenomenon affected by the information resources, organisational resources, and the people resources of organisations. As such this framework aids problem solvers understand the interconnections between different emerging perspectives and extends the ideas put forward by previous research.

A framework enables the compilation of ideas in a manner that presents the interconnection of different elements thereby showing the relationship between such elements. The OED, (2015) defines a framework as a basic structure underlying a system, concept, or text. It is often the case that the term framework is used interchangeably with models. Therefore it is imperative to draw the difference between these terms in relation to this study. A model is defined as a simplified description, especially a mathematical one, of a system or process, to assist calculations and predictions (OED, 2015). Models facilitate simplification that promotes understanding, enables simulation, aid in discovering inconsistencies, and encourage generalisation (Muller, 1997). According to Muller, (1997) this is achieved by providing an abstract description of a system or a process. On the contrary, frameworks provides interpretations of relationships between variables which promotes explanations and predictions for empirical observations (Grix, 2001) . Grix, (2001) further argues that models are less complex tools for comparing and classifying phenomena. Ravitch & Riggan, (2012) views frameworks as the linking of concepts. In detail Ravitch & Riggan,

(2012) explains frameworks as a series of sequenced logical propositions which is meant to highlight the importance of the concepts and promote rigor

IQ is a multi-dimensional phenomenon affected by the information resources, organisational resources, and the people resources of organisations (Koronios et al., 2005; Liu & Chi, 2002; Nutt & McLennan, 2002; Pipino et al., 2002; Slone, 2006). Koronios et al., (2005) states that a critical concern with AM is the lack of quality information due to the dependence of traditional data source to manage AM activities. These traditional sources often fail to reflect both the tacit and implicit knowledge of operators and information contained in information systems, which have been designed for the specific purpose of increasing productivity, rather than efficiency of the process. Koronios et al., (2005) further argue that any framework should take into consideration the stakeholders' perspective. This approach aids problem solvers understand the interconnections between different emerging perspectives i.e. information domain perspective, organisational domain perspective, and people domain perspective

The development of this framework has been based on the ability to capture the voice of the people through the qualitative phase of the research (R. W. Wang, Strong, Richard, & Diane, 1996). Wang et al., (1996) highlights that the study of information quality may adopt different approaches; (1) an intuitive approach, (2) a theoretical approach and (3) an empirical approach. According to Wang et al., (1996) an intuitive approach is taken when the study is based on the researcher's experience or intuitive understanding. This, however, increases the level of bias in the study. The theoretical approach, according to Wang et al., (1996) focuses on how information may become deficient within the operational context. The problem with this method is it concentrates on the development characteristics i.e. the technical resources instead of the use characteristics i.e. the organisational and the people resource. The empirical approach, on the other hand, takes into consideration the people and organisational resources to understand the issues associated with information quality (R. W. Wang et al., 1996). Wang et al., (1996) posited that the empirical approach analyses data collected from information consumers and the organisations as well as the technology of use to determine what characteristics is used to assess the fitness of use of information. R. W.

Wang et al., (1996) argues that these features cannot be theoretically or intuitively determined. This research has actively adopted an empirical approach in investigating IQ and towards the development of the framework.

The framework developed in this research extends the ideas put forward by Koronios et al., (2005) and Wang et al., (1996). A significant limitation of the ideas posited by Koronios et al., (2005) and Wang et al., (1996) was the lack of a tool to assess the quality of information once the attributes were defined. Secondly, their ideas crucially omitted the structure and size of the organisation. It has been noted that the structure of the organisation has been found to influence the flow of information (Mintzberg, 1979; WILLMER, 1977). However, as with Koronios et al., (2005) and Wang et al., (1996), these studies have failed to determine if the size or structure of the organisation has a main effect on IQ. Thus, the framework developed in this study has taken into consideration the size and structure of the organisation and their influence on IQ. In addition to this, information from the operational context has further determined what parameters are to be included and measured in organisation domain. Finally, a tool to assess the IQ has been formalised based on parameters derived from the quantitative data analysis components.

To conclude, the framework presents the collection of elements that has emerged from the literature review and analysis of the data which explains the key factors, constructs, variables, and relationship among them in a graphical way. As specified in Chapter 3, the framework uses the techniques of cause-and-effect and perceptual map formulate the final design of the framework. The application of these concepts is shown in the succeeding section.

6.2.1 Cause-and-Effect Diagram

Based on the arguments stated above, the cause-and-effect diagram was applied in the research to present the interaction of the various elements found to influence the quality of information in AM programs by FM (see Section 4). The elements of the diagram include the information domain, organisation domain, and the people domain making up the asset information quality influencing factors (Figure 6:1). Each domain expressed factors that influenced the nature of that domain. For instance, behaviour, development, and skill influenced the people domain (see Table 4.4). Following on from this, the organisation structure assessed the prevalence of IQ in FM organisation undertaking AM programs. It was seen here that the size of the organisation acted as a moderating factor that influenced the quality of information whereas the structural level i.e. strategic, tactical, and operational had the main effect on IQ. The main dimensions of IQ is finally presented in the diagram under the “Asset Management IQ dimension” category.

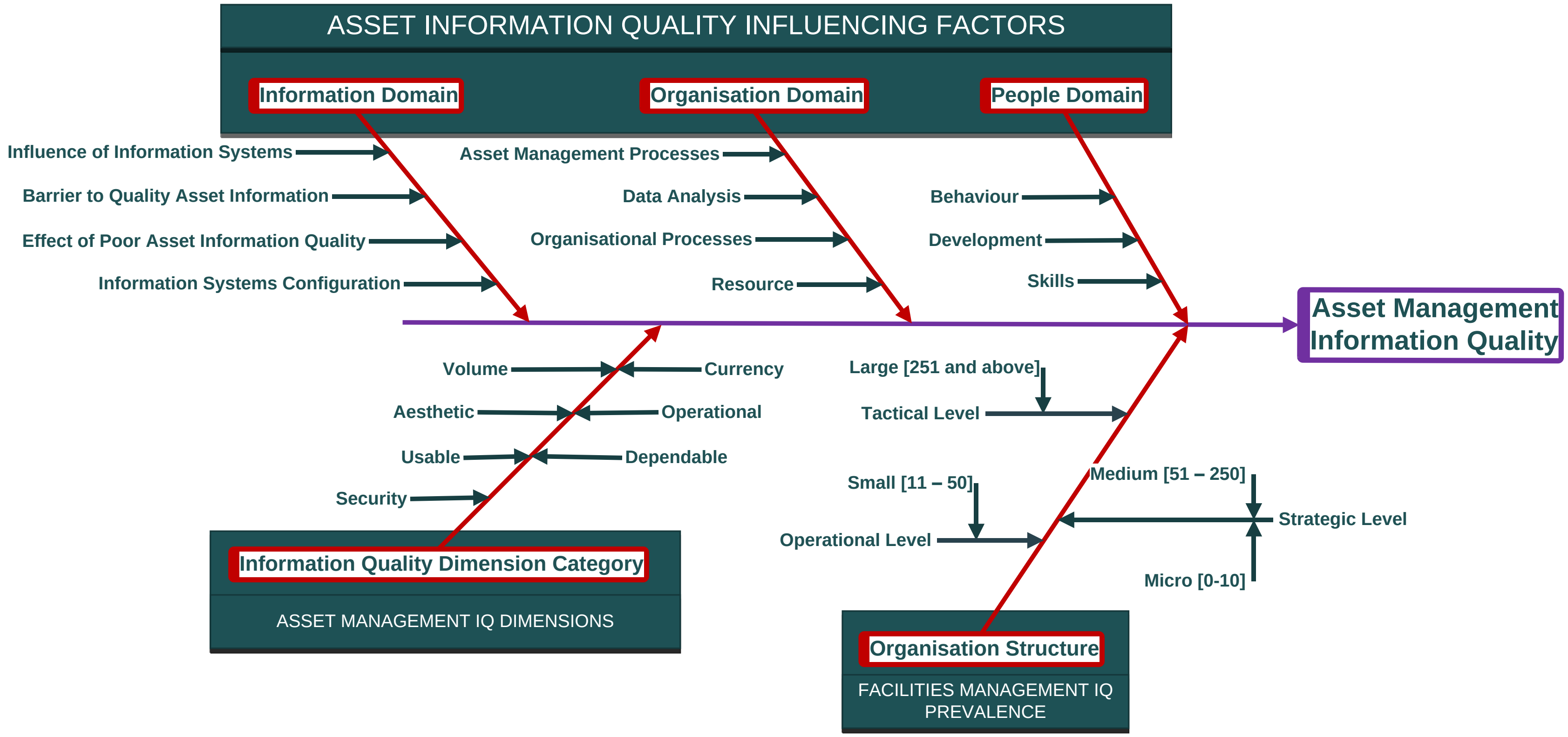


Figure 6:1 Asset Management Information Quality Cause-and-Effect Diagram

6.2.2 Perceptual Map

The second part of the framework is the development of the perceptual map (see Chapter 3). The perceptual map developed in this research maps the IQ dimension in a 2-dimensional space and explains the association of each dimension in relation to the others (see Appendix XI and Figure 6:2). As indicated in Chapter 3 , the benefit of using the perceptual map in the context of this research resides in the methodological principles adopted. This research has used principal component analysis (PCA) to determine the quality dimensions of information which suitably fits the use of a perceptual map in assessing the quality of information (Gower et al., 2014; Mojtahed et al., 2014).

In developing the perceptual map, the following axes (1) Horizontal [*x*] Axis: Importance IQ Level, and (2) Vertical [*y*] Axis: Perceived IQ Level, suggests the underlying factors that best characterise how information recipients differentiate between alternative IQ dimensions (Figure 6:2). In addition to this, the axes complies with the variables used in the questionnaire to determine the prevalence of IQ issue in FM operation and the importance of specific IQ attributes (see Appendix VIII and Appendix X). The perceptual map adopted in this research further classifies the map into four (4) quadrants based on the "*y" and "x"* axes connotation:

1. Top right: *HpHi (Excellent)*
2. Top left: *HpLi (Good)*
3. Bottom right: *LpHi (Improvement Needed)*
4. Bottom left: *LpLi (Poor)*

Based on this, IQ dimension falling into the *HpHi* quadrant indicates that the level of quality is of very high standard and is fit for purpose, while IQ dimension(s) falling into the *LpLi* quadrant indicates that the quality of information based on those dimension is poor or not relevant accordingly. As an addendum, the quadrants provide the ability to make relevant decision in improvement strategies based on the identified factors in the cause-and-effect diagram. An added advantage of using the perceptual map is the ability to determine the perceived quality of information in 2-dimensional space in relation to its importance for a specific operational unit, hierarchal level, or departmental unit with the view of taking necessary improvement actions.

Using the perceptual map process, the IQ attributes identified in phase 1 of this research, deemed important to the participants of the research (see Section 4.2 , were applied to the process (see Appendix XI). The frequency scores were used to determine the level of importance and the perceived quality level. The result from this tabulation displayed the IQ dimensions that are relevant to the practitioners involved in AM. From this result, it is seen that the Form and Content dimensions fell into the “Top right: HpHi (Excellent)” quadrant, while, Time, Validity, and Available IQ dimension fell in the Bottom left: LpLi (Poor) quadrant. Though, the dimension Accessibility fell into the Bottom left: LpLi (Poor) quadrant, it was close to the median point on the map. It can thus be concluded that this method can be used to visualise the IQ associated with a specific operation within a specific context.

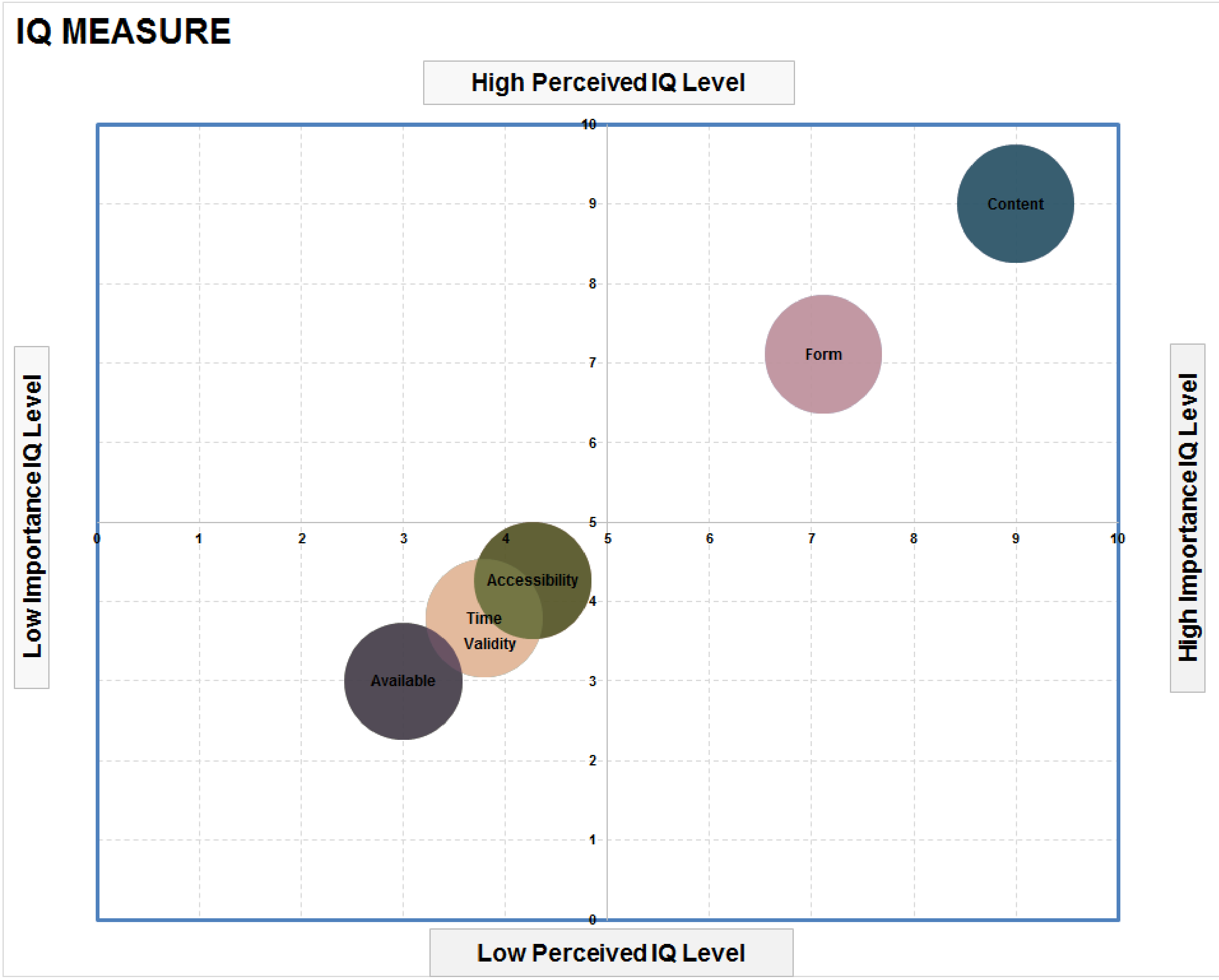


Figure 6:2 Perceptual Map (PerMap) for IQ Assessment

6.2.3 Framework Elements Operationalization

The preceding section has introduced the development of the framework including its elements based on the results in this research. This has been applied using established principles in quality management i.e. cause-and-effect (Ishikawa) diagrams and perceptual map. However, this does not explain how these principles relate to achieve the common goal of IQ improvement. In essence, it is perceived as two (2) disparate constructs. Therefore it is important to presents the constituted framework which shows how these apparently disparate construct feeds into a holistic method for assessing IQ in AM programs undertaken by FM operations (Figure 6:3). This process operationalizes the framework for use within an operational context.

The framework combines the elements from the cause-and-effect diagram and perceptual map. The first elements from the cause-and-effect diagram are the information, organisational, and people domains where identified factors are seen to influence the operation (see Section 4.1). This forms the operational context where decisions, tasks, and actions that require a level of quality in information are made. Here there is a constant interaction within the three domains that facilitates the flow and use of information. Based on the cause-and-effect diagram, the factors that influence the quality of information can be monitored to improve the quality of information.

The second element from the cause-and-effect diagram is the structure of the organisation. The operational context is seen to be determined by the structure of the organisation which is based on the model of Mintzberg, (1979) (see Section 5.4). Both the operational context and the structure of the organisation are moderated by the size of the organisation (see Section 5.5.2). In addition, both the operational context and the structure of the organisation have a primary effect on the quality of information (see Sections 4.1 and 5.5).

The third element from the cause-and-effect diagram is the information quality dimension/attributes. The information quality dimensions explains and determines the level of information quality expressed within the operational context (see Section 5.6).

The identified IQ dimensions are in turn subjected to an assessment using the perceptual map (PerMap). This utilises a spreadsheet that captures the values for each IQ dimension and scores them on a scale of 1 – 9 (see Appendix XI). The results from the PerMap are further used in IQ improvement programs based on the identified factors that results in information quality issues (see Chapter 4 and Chapter 5) within the operational context. The constituted framework is presented in Figure 6:3.To apply the concepts of the framework in an operational context, the following steps are to be taken:

1. The specific IQ dimensions (attributes) are identified within the operation that is relevant to the actions being performed. These IQ dimensions (attributes) have been provided in a spreadsheet (Appendix X and Appendix XI)
2. The selected IQ dimensions (attributes) are assessed for its quality using the perceptual map which forms part of the spreadsheet. The values assessed are “importance” and “perception” (see above). This will provide the scores and positioned within a particular quadrant on the perceptual map
3. Based on the result from the perceptual map, specific actions can be instituted to improve the quality of information based on factors within the information domain, organisational domain, and people domain which forms part of the cause and effect diagram (see above)
4. The assessor must take in to consideration the structure of the organisation when carrying out these assessment in order to ensure the desired outcome are effective as this will determine the factors to focus on and influence IQ

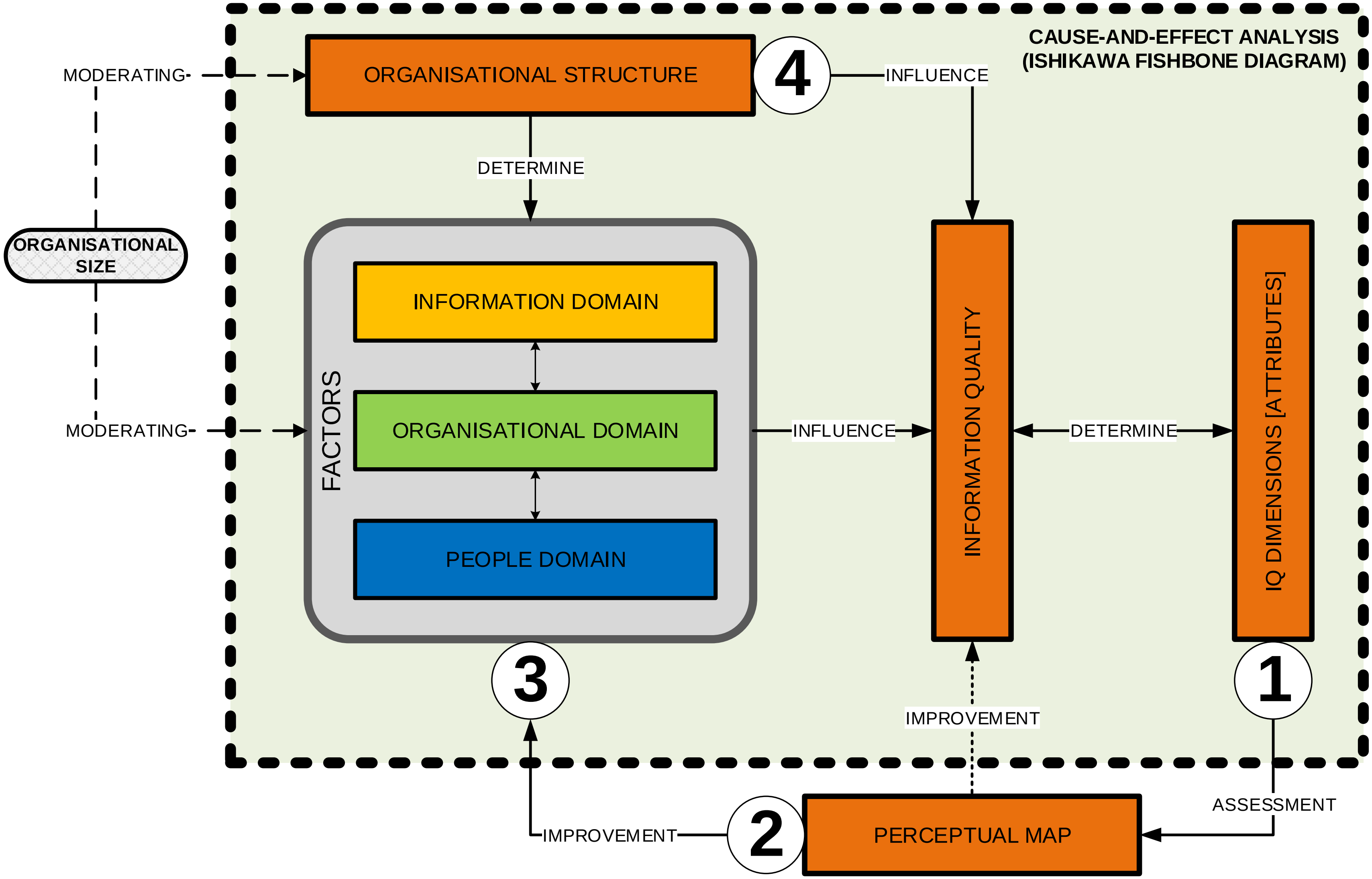


Figure 6:3 The Information Quality Assessment Perceptual Map (IQAPerMap) Framework

6.3 Framework Validation

It has been noted in information quality research that previous developed framework required improvement in several areas to be useful to practitioners and researchers (Eppler, 2001). These areas pointed out by (Eppler, 2001) include: (1) applicability of the framework, (2) interdependencies between different quality criteria, (3) inclusion of problem areas and solution elements, (4) development of tools based on the framework, and (5) development of the framework rooted in theory. To this end, there is the need to verify and determine if the structure of the developed framework satisfies the criteria. This is achieved by determining the correctness of the structure of the framework by examining the output under a given set of measures (Fellows & Liu, 2003). Validation refers to the process of finding or testing the truth of something (TheSage English Dictionary and Thesaurus, 2014). According to Bryman, (2008) the process of validation entails returning to the source of data and requesting feedback on the findings.

6.3.1 Validation Process

The validation process solicited expert opinion from practitioners within the BE engaged with AM. The approach to determining the sample used in the validation process was premised on the methodology and sampling technique adopted in the research (see Chapter 3). The opinions were obtained using a questionnaire consisting a five-point Likert scale ranging from “Least” to “Extremely” with corresponding weighting as follows: 1 = Least, 2 = Low, 3 = Moderate, 4 = Very, 5 = Extremely (see Appendix XII). The questions contained in the questionnaire included closed-ended and open-ended questions. The close-ended questions formed the Likert scale questions while the open-ended question requested additional information not captured through the Likert-scaled questions.

The framework was evaluated based on analytic (scientific) and pragmatic (operational) criteria as suggested by Eppler & Wittig, (2000). According to Eppler & Wittig, (2000), analytic criteria is based on academic standards, which requires a clear definition of the terms used in the context, positioning of the framework within the existing literature and theory, and a consistent and systematic structure in applying the framework, while the pragmatic criteria that make a framework applicable in the operational context include conciseness, illustration, and the practicability of the framework (Table 6:2).

Table 6:2 Evaluation Criteria for Information Quality Frameworks based on Eppler & Wittig, (2000)

Evaluation Criteria	Focus	Evaluation Questions (*Adapted Questions used in Questionnaire*)
Analytical (Scientific)	Definition	Are all individual terms of the framework clearly defined?
		(*How well defined are the terms and concepts of the framework? (+)*)
	Positioning	Has the context of the framework been made clear?
		(*How well does the framework apply in your job in assessing information quality? (+)*)
	Consistency	Are the elements of the framework mutually exclusive and collectively exhaustive?
		(*How well do you feel the framework is consistent in solving information quality problems? (+)*)
Pragmatic (Operational)	Concise	Does the framework contain a relatively small amount of element?
		(*Do you feel there are too many elements in the framework? (-)*)
	Illustration	Can the framework be illustrated through examples such as presentations, training or case studies?
		(*Can the framework be demonstrated easily to others? (+)*)
	Practicability	Can the framework be used as a tool to improve real-life problems?
		(*Can the framework be used as a tool to improve information quality issues (+)*)

The questionnaire, along with the framework, perceptual map, and background to the research was sent out to 15 carefully selected respondents. They were asked for comments, which in their view, can improve the framework.

6.3.2 Validation Data Analysis

Data collected from the survey based on the validation process was analysed using SPSS version 22 software package. The analytical technique adopted in this instance was descriptive where the mean, median, standard deviation and frequency statistic was determined for each validation question in detail. The aim was to explore experts understanding and opinion in relation to the framework in assessing information quality within the context of asset management. A total of 15 questionnaires was distributed with eleven (11) returned. However, it was observed that only eight (8) was accurately filled and suitable for analysis thus giving an overall response rate of 95.88%.

A frequency analysis was performed on the characteristics of the respondents to determine the gender and the organisation level of each respondent. It was observed that 62.5% of the respondents were male while 37.5% of the respondent were female (Table 6:3 and Figure 6:4)

Table 6:3 Gender of Respondents in the Validation Process

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	5	62.5	62.5	62.5
	Female	3	37.5	37.5	100.0
	Total	8	100.0	100.0	

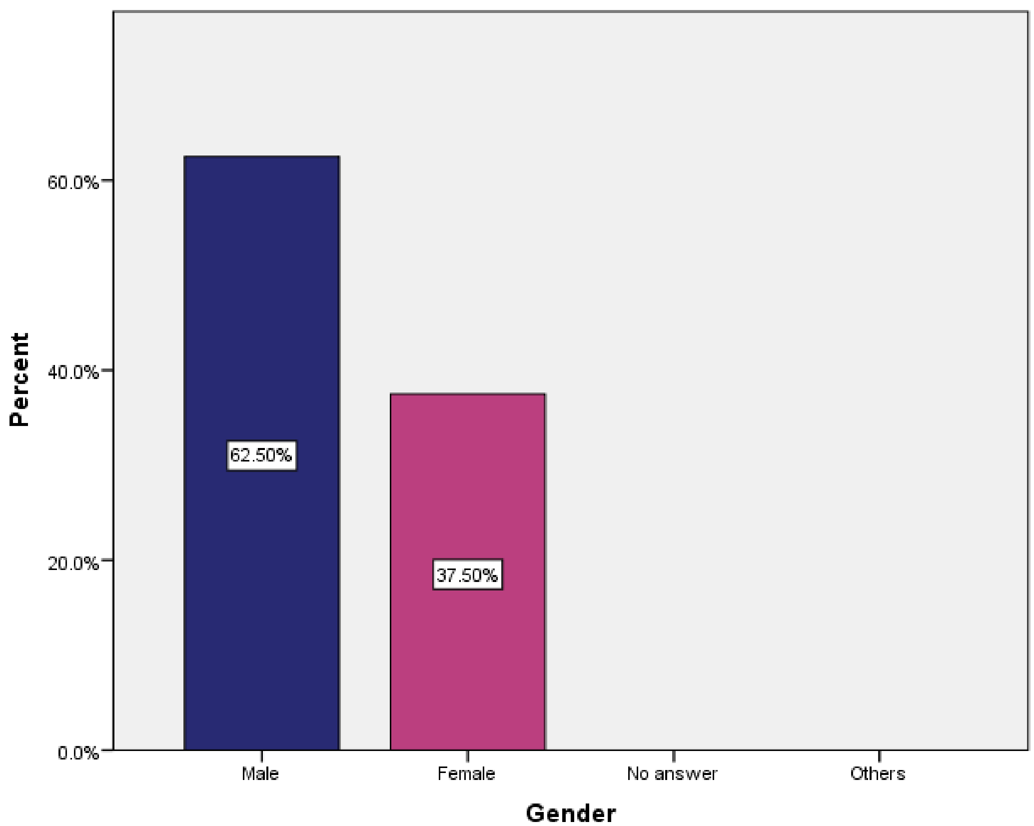


Figure 6:4 Gender of Respondents in the Validation Process

Also, the respondents were further classified based on the level within the organisation they operate in i.e. strategic, tactical, and operational. The essence of this was based on the premise that the perception of information quality will differ based on the organisational hierarchy thus the applicability of the framework will differ somewhat. Based on the analysis, 25% of the respondent were made up of the strategic and operational levels respectively while 50% of the respondent were made up of the tactical level (Table 6:4 and Figure 6:5).

Table 6:4 Organisation Level of Respondents in the Validation Process

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strategic	2	25.0	25.0	25.0
	Tactical	4	50.0	50.0	75.0
	Operational	2	25.0	25.0	100.0
	Total	8	100.0	100.0	

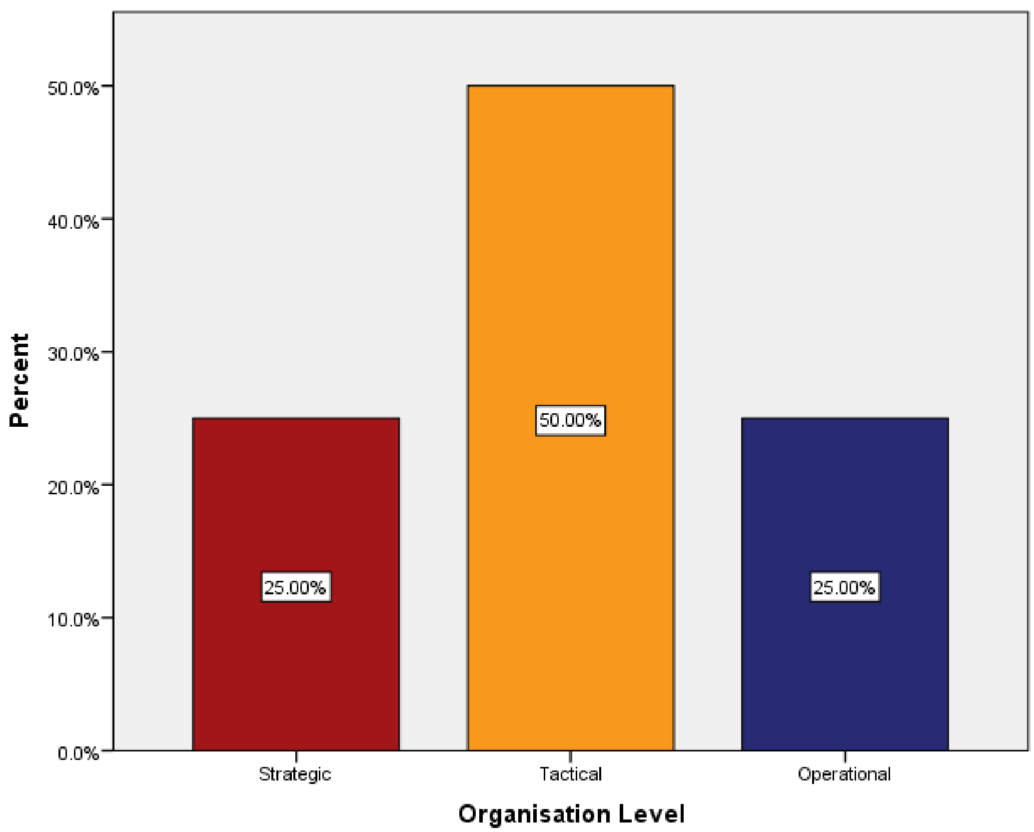


Figure 6:5 Organisation Level of Respondents in the Validation Process

As indicated by Eppler & Wittig, (2000), the framework was evaluated based on analytic (scientific) and pragmatic (operational) criteria. The specific questions asked are presented in Appendix XII The following statistics: mean, median, standard deviation, variance, skewness, standard error of skewness, kurtosis, and standard error of kurtosis were computed to assess the relevance of each criteria (Table 6:5). In addition frequency, tables were computed for each criteria where the information were displayed in histograms graphs. The histogram graphs provided information about the distribution of scores for each assessed criteria (J. Pallant, 2013).

Table 6:5 Validation Statistics

		Definition	Positioning	Consistency	ConciseR	Practicability	Illustration
N	Valid	8	8	8	8	8	8
	Missing	0	0	0	0	0	0
Mean		4.25	4.00	4.00	4.38	4.13	3.13
Median		4.00	4.00	4.00	4.50	4.00	3.00
Std. Deviation		.707	.756	.756	.744	.641	.991
Variance		.500	.571	.571	.554	.411	.982
Skewness		-.404	.000	.000	-.824	-.068	.862
Std. Error of Skewness		.752	.752	.752	.752	.752	.752
Kurtosis		-.229	-.700	-.700	-.152	.741	.840
Std. Error of Kurtosis		1.481	1.481	1.481	1.481	1.481	1.481

The first criterion evaluated was the definition criteria. This criterion sought to determine if all individual terms of the framework was clearly defined. Based on the result of the analysis, the value of the mean for this criteria was 4.25 (median = 4.00) with standard deviation of .707 (Table 6:5). The skewness of the histogram was inspected to determine the symmetry of the distribution of scores. According to (J. Pallant, 2013), positive skewness values indicate the scores are clustered to the left at the low values while negative skewness values indicate a clustering of scores at the right high-end side of the histogram graph. On inspection of the histogram, the definition criterion had a negative skewness with value of -.404 which indicated the clustering of values on the high-end side of the graph (Table 6:5). On inspection of the frequency table for the definition criterion (Table 6:6), 50% of the respondent rated the criterion very high while 37.5% rated the criterion extremely high. This corroborates the observed skewness of the histogram (Figure 6:6). Thus, this suggests that respondents perceived the elements of the framework were well defined within the application context.

Table 6:6 Definition Frequency Scores

Definition

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Moderate	1	12.5	12.5	12.5
	Very	4	50.0	50.0	62.5
	Extremely	3	37.5	37.5	100.0
	Total	8	100.0	100.0	

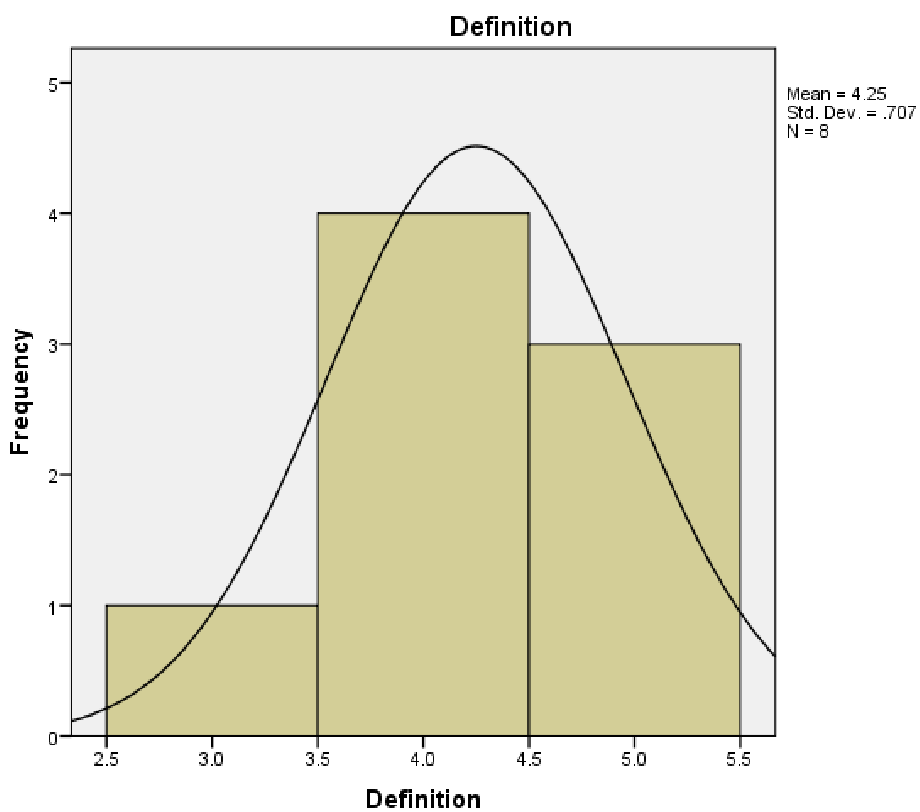


Figure 6:6 Definition Criteria Histogram

The next criteria assessed was the positioning criteria which sought to determine the applicability of the framework in an operational context. This criteria had a mean value of 4.00 (median = 4.00) with a standard deviation of .756 (Table 6:5). The criteria was positively skewed with a value of .000 which indicated a clustering of scores at the centre of the graph and a normal distribution (Figure 6:7). On inspection of the frequency table for the positioning criterion (Table 6:7), 50% of the respondent rated the criterion very high while 25% rated the criterion moderately and extremely high respectively. This corroborates the observed skewness of the histogram, which suggests the framework is well placed within an operational and theoretical context.

Table 6:7 Positioning Frequency Scores

Positioning

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Moderate	2	25.0	25.0	25.0
	Very	4	50.0	50.0	75.0
	Extremely	2	25.0	25.0	100.0
	Total	8	100.0	100.0	

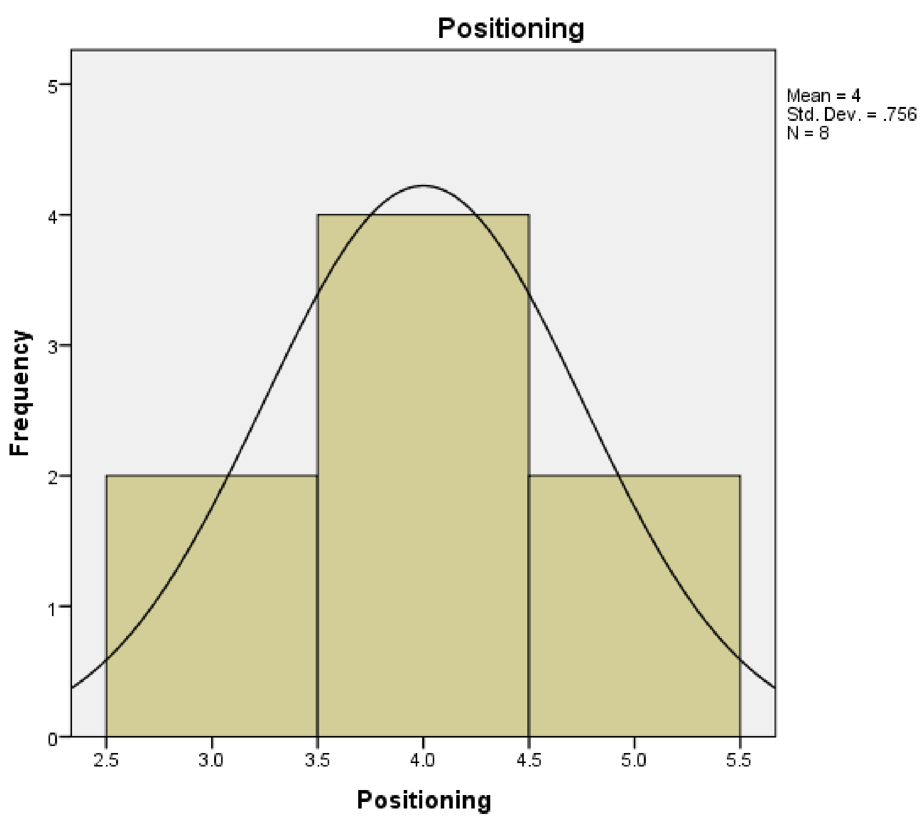


Figure 6:7 Positioning Criteria Histogram

The next criteria evaluated is the consistency which had a mean of 4.00 (median = 4.00) and standard deviation of .756 (Table 6:5). This criterion was aimed at evaluating if the elements of the framework were mutually exclusive and collectively exhaustive by determining how well the framework is consistent in solving information quality problems. This criteria had a skewness value of .000 which indicated a normal distribution of the score being positive (Figure 6:8). On inspection of the frequency table for the consistency criterion (Table 6:8), 50% of the respondent rated the criterion very high while 25% rated the criterion moderately and extremely high respectively which suggests the criteria was satisfied.

Table 6:8 Consistency Frequency Scores

Consistency

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Moderate	2	25.0	25.0	25.0
	Very	4	50.0	50.0	75.0
	Extremely	2	25.0	25.0	100.0
	Total	8	100.0	100.0	

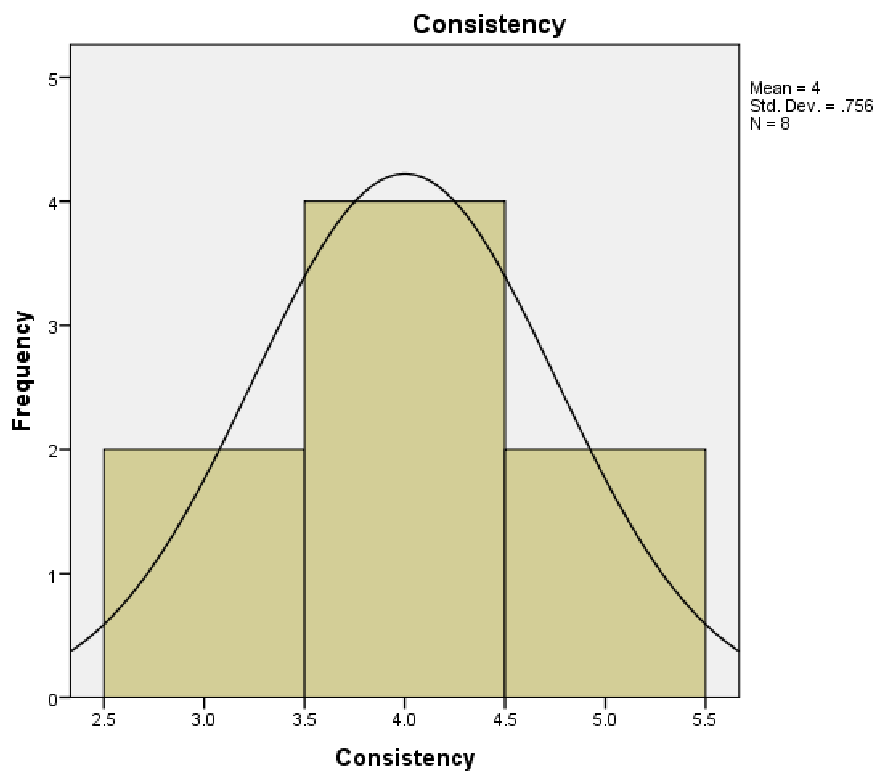


Figure 6:8 Consistency Criteria Histogram

Conciseness was the criteria assessed after consistency. This criterion was negatively worded to ensure that response bias was minimised. The evaluation question suggested by Eppler & Wittig, (2000) was: *"…does the framework contain a relatively small amount of element...".* However, this was deemed a risk in introducing bias hence the question was worded as follows: *"…Do you feel there are too many elements in the framework? (-))…"*. The scale rating was subsequently reversed in SPSS and the variable was renamed "ConciseR". Remarkably, the result from this approach had a mean value of 4.38 (median = 4.50), with standard deviation of .744. Further assessment of the skewness showed a very high negative value of -.824. This indicated that the score values clustered at the high end of the histogram (Figure 6:9). On inspection of the frequency table for the conciseness criterion (Table 6:9), 50% of the respondent rated the criterion least while 37.5% rated the criterion. The interpretation of this suggests that there are too many elements in the framework thus making it difficult to read. Uniquely, this view was expressed by one of the respondents as follows:

> *"…The framework certainly has potential though is difficult to understand at face value and may require an instructional blurb or something similar. Certainly very interesting…"*

Table 6:9 Conciseness Frequency Scores

ConciseR

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Moderate	1	12.5	12.5	12.5
	Low	3	37.5	37.5	50.0
	Least	4	50.0	50.0	100.0
	Total	8	100.0	100.0	

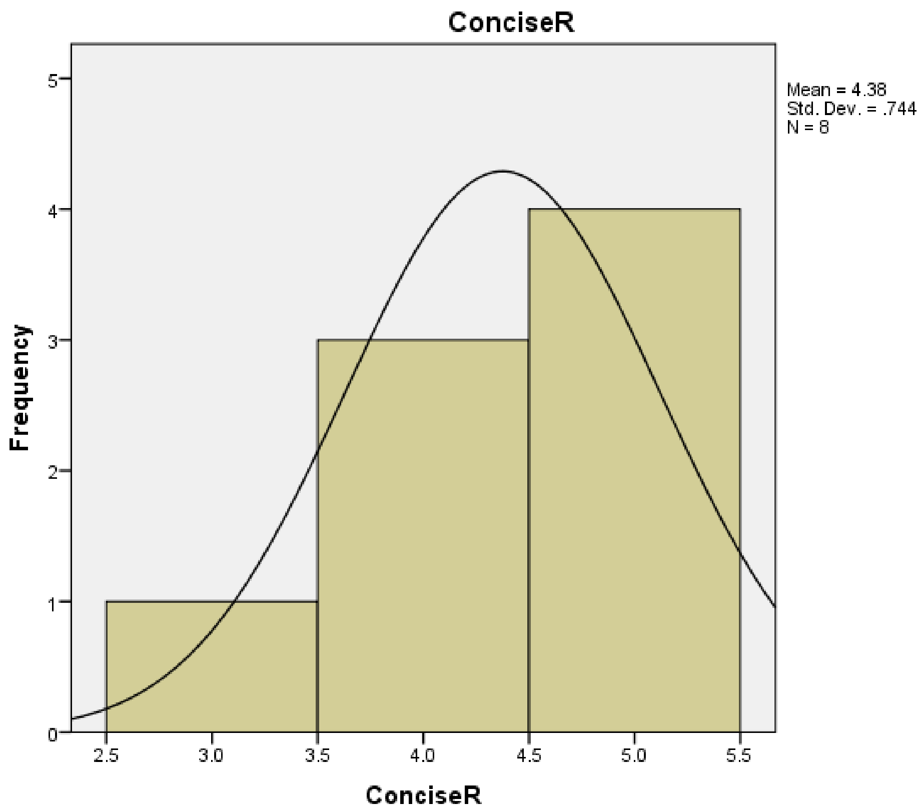


Figure 6:9 Concise Criteria Histogram

Following on from the concise criteria was the evaluation of the practicability criteria. The value of the mean for this was 4.13 (median = 4.00) with standard deviation of .641 (Table 6:5). This criterion sought to assess the ability of the framework to be used as a tool to improve real-life problems. On inspection of the histogram, the criteria had a skewness of -.068 which suggested normal distribution clustering slightly to the high-end side of the graph (Figure 6:10). On inspection of the frequency table for the practicability criterion (Table 6:10), 62.5% of the respondent rated the criterion very high while 25% rated the criterion extremely high. Thus, it was determined that the framework may be applied as a tool to solve real-life information quality problems.

Table 6:10 Practicability Frequency Scores

Practicability

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Moderate	1	12.5	12.5	12.5
	Very	5	62.5	62.5	75.0
	Extremely	2	25.0	25.0	100.0
	Total	8	100.0	100.0	

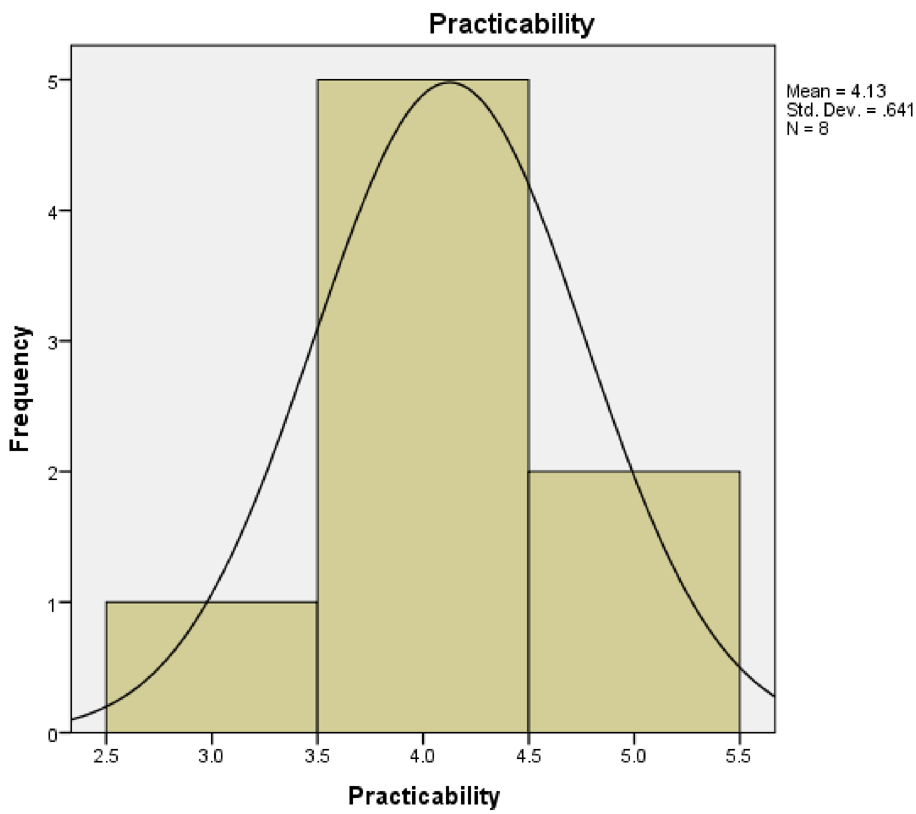


Figure 6:10 Practicability Criteria Histogram

Finally, the last criteria assessed was the illustration criteria. This was aimed at determining the ease at which the framework could be illustrated through examples such as presentations, training, or case studies. The result from the analysis gave a mean of 3.13 (median = 3.00) (Table 6:5). This was observed to be on the low end of the scale having a standard deviation of .991 and skewness of .862 (positively skewed) (Figure 6:11). Further inspection of the frequency table for the illustration criterion (Table 6:11) indicated that 50% of the respondent rated the criterion as moderate while 25% rated the criterion as low. 12.5% rated the criterion as very and extremely high respectively. This suggested that the framework was not easily illustrated through examples as required by the criteria condition. This value was deemed similar to the conciseness criteria, which thus requires simplification and guidance for use.

Table 6:11 Illustration Frequency Scores

Illustration

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Low	2	25.0	25.0	25.0
	Moderate	4	50.0	50.0	75.0
	Very	1	12.5	12.5	87.5
	Extremely	1	12.5	12.5	100.0
	Total	8	100.0	100.0	

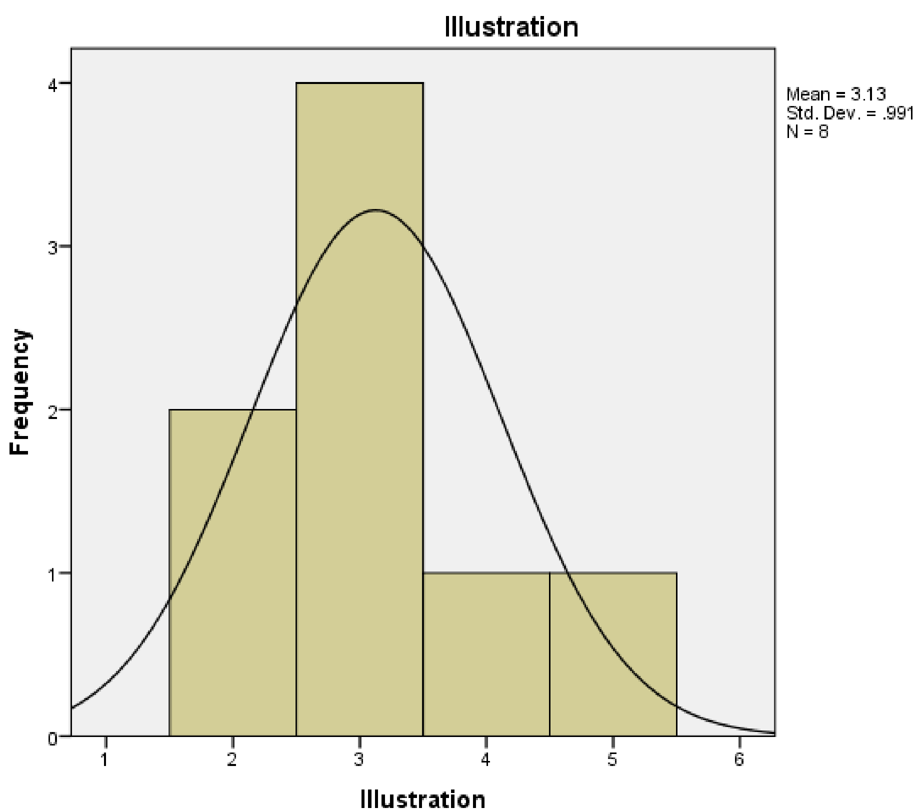


Figure 6:11 Illustration Criteria Histogram

6.4 Summary

This chapter presented the discussion of the key results based on the analysis of the qualitative and quantitative data (Chapter 4 and Chapter 5) which was summarised through the synthesis of each chapter results and findings. This was followed by the development of the framework which was subsequently validated. The development of the framework was facilitated by the key finding from the literature review, qualitative data analysis and the quantitative data analysis. The framework was developed using established tools in the quality discipline. These were the cause-and-effect diagram (Ishikawa fishbone diagram) and the perceptual map. Both tools were further synthesised into the framework titled Information Quality Assessment Perceptual Map (IQAPerMap). The validation of the framework was further achieved by a questionnaire survey of expert opinions in the built BE industry based on the guidance postulated by Eppler & Wittig, (2000). This was aimed at assessing the suitability of the framework based on analytic (scientific) and pragmatic (operational) criteria. The analysis of the data derived from the questionnaire was facilitated by the use of SPSS ver 22 software. The analytical procedure conducted was frequency, mean, median, and standard deviation. Prior to the analysis, the demographic of the respondent was determined. From here it was noted that there were more male respondents than female respondents and the predominant organisation level responding to the survey was the tactical level. The result from the analysis showed that there were areas of concern in the framework which was predominantly situated in the pragmatic (operational) level (Table 6:12) having a cumulative mean score of 3.21 (Figure 6:12). However, the framework achieved positive scoring at the analytic level with a cumulative mean score of 4.08 (Figure 6:12). It is thus recommended that the framework be refined and further test of the modified framework should be subjected to a case study to determine its suitability and adaptability.

Table 6:12 Validation Score of Framework

Evaluation Criteria	Focus	Evaluation Questions	Score
Analytical (Scientific)	Definition	Are all individual terms of the framework clearly defined?	4.25
	Positioning	Has the context of the framework been made clear?	4.00
	Consistency	Are the elements of the framework mutually exclusive and collectively exhaustive?	4.00
Pragmatic (Operational)	Concise	Does the framework contain a relatively small amount of element?	2.38[26]
	Illustration	Can the framework be illustrated through examples such as presentations, training or case studies?	4.13
	Practicability	Can the framework be used as a tool to improve real-life problems?	3.13

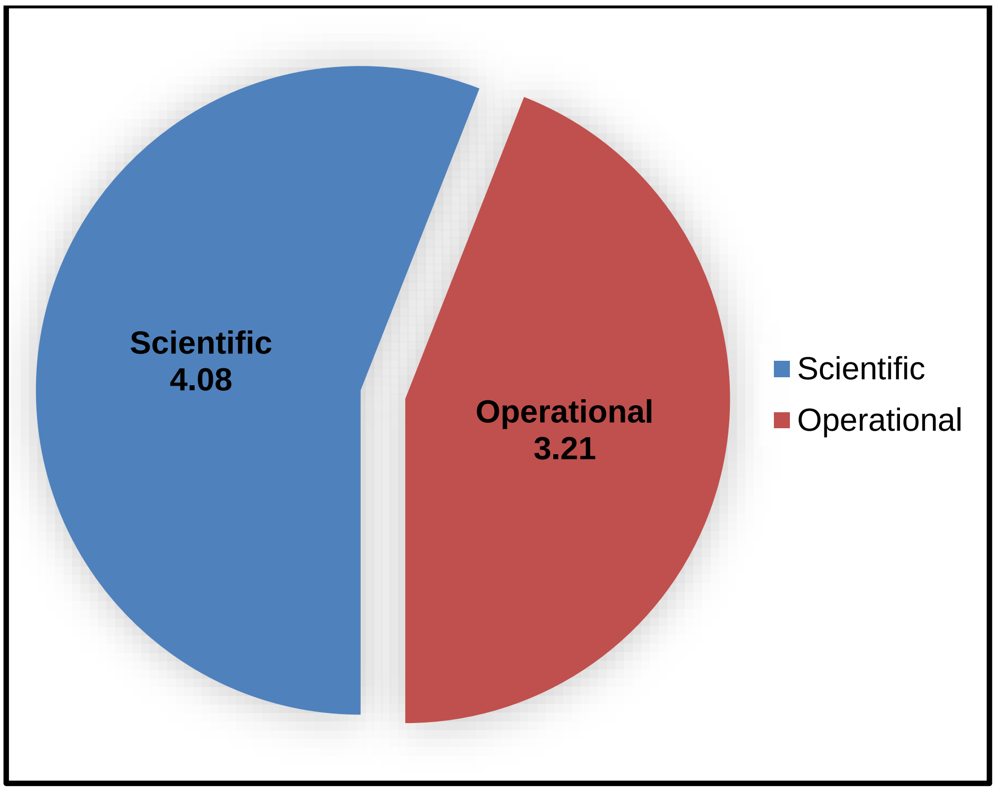


Figure 6:12 Cumulative Validation Score of Framework

[26] Based on negative wording of question in the questionnaire

Chapter 7 Conclusions and Recommendations

This section presents the conclusions and recommendations based on the research findings which has been informed by the aim and objectives of research. This study set out to examine the issue of information quality in asset management undertaken by facilities management organisations. The theoretical principles underpinning the issue were examined in the study and the key factors influencing the quality of information were presented. This research also sought to develop a framework to facilitate the assessment of the quality of information. Based on this a perceptual map tool, established on the identified information quality dimensions, was formulated which aim to provide practitioners the ability to visualise the quality of information. This chapter summarises the main conclusions regarding the results of the study premised on the research objectives. The contributions this study have made will be outlined. Given this, the limitations of research has been recognised, and recommendations for future studies have been suggested.

7.1 Research Justification, Aim and Objectives Revisited

The scope for this study was presented in Chapter 1 where the aim and objectives of this research were outlined. The aim of the research was to develop a framework to enable facilities management professional assess the quality of information used in asset management programs. Facilities management was seen to be a significant facet of the BE. It was noted that the financial value of the industry was very significant. However, a major problem identified was the loss of contracts and risk to jobs, which undermined the significance of the industry. In an attempt to resolve this challenge, the concept of asset management has been adopted, which enables the management of risk, cost, and performance in the industry. However, it was acknowledged that the issue of information quality was a significant problem in asset management but was also a concept difficult to measure. The problem of measurement has been found to be multi-faceted. Based on this notions the questions this research sought to answer were as follows:

1. How prevalent is the issue of information quality (IQ) in the (FM) industry?
2. Which IQ dimensions are significant for effective asset management (AM) activities?
3. How can the quality of asset information be assessed in FM operations?

In light of this, it was acknowledged that the effectiveness of asset management undertaken by facilities management organisation requires the ability to assess the quality of information used. Based on this premise, the objectives of the research was formulated and are presented as follows:

1. To examine what factors influence asset management (AM) information quality (IQ) in facilities management (FM)
2. To determine the prevalence of information quality (IQ) issue and influence of organisation structure and size on information quality in facilities management industry
3. To identify the information quality (IQ) attributes specific to asset management (AM) in facilities management operations (FM)
4. To classify the information quality (IQ) attributes into specific information quality (IQ) dimensions within the context of asset management (AM) in facilities management (FM)
5. Develop and evaluate a framework to improve information quality (IQ) of asset management (AM) activities in facilities management (FM) through expert groups

The subsequent section outlines how each of these objectives have been achieved within the thesis.

7.2 Summary of Main Findings and Achievement of Research Objectives

This section provides a summary of how each objective was met and the main findings from the research. Within this, a discussion of the findings from each objective is presented. This shall be preceded with an outline of which technique was used in achieving each objective. Based on the exhaustive analysis and literature review, the following were considered to be the significant findings from this study:

1. A total of 12 IQ dimensions were determined and grouped into 7 categories which indicates that IQ affecting AM is a multi-dimensional concept and should be determined and assessed contextually
2. The organisation structure has a significant effect on IQ with the size of the organisation having a moderating effect
3. IQ improvement should be considered from three (3) domains:
    a. Information domain
    b. Organisational domain
    c. People domain

The following subsection below elaborates on these findings.

7.2.1 RO1 – To Examine What Factors Influence Asset Management (AM) Information Quality (IQ) In Facilities Management (FM)

This objective was achieved by means of a detailed literature review and qualitative data analysis (see Chapter 2 and Chapter 4). The method of qualitative data analysis adopted was thematic analysis. The literature review provided preliminary evidence of several factors that influenced the quality of information in organisation which were broadly segmented into three (3) domains i.e. information, organisation, and people domains. These were further examined within an organisation context via semi-structured interview. The data collected from the interviewees were analysed using thematic analysis and this was classified into the three domains based on the extant literature:

1. The information domain
2. The organisation domain
3. The people domain

Based on the analysis eleven (11) key factors were identified to influence asset management information quality (see Figure 4:8). Each of the identified factor was corroborated with the extant literature to ascertain its validity. These factors were organised into themes, which included subthemes. It was observed that under the information domain, the theme “Barrier to Quality Asset Information” had the highest number of references (34.55%) made concerning this issue (Appendix III). This was seconded by “Information Systems Configuration” with 28.18% references made. Under the organisation domain (Appendix IV), the theme “Organisational Processes” had the highest number of references made to it (50.67%). This was followed by “AM Processes” with 26.67% references. In the people domain, “Development” and “Behaviour” themes had very close values of 41.67% and 37.50% respectively (Appendix V). In essence, the magnitude of these values suggested the level of concerns associated with factors influencing IQ as expressed by the participants undertaking AM programs in facilities management. However, further investigation into these issues needs to be explored to ascertain the impact on performance, cost, risk, and quality of service.

7.2.2 RO2 – To Determine the Prevalence of Information Quality (IQ) Issue and Influence of Organisation Structure and Size on Information Quality in Facilities Management Industry

This objective was achieved using a quantitative analysis approach. The techniques adopted within the quantitative analysis were descriptive and parametric statistics (ANOVA) respectively. Data on the prevalence of IQ issue in FM was captured assessed using a 9 point Likert scale via descriptive analysis (see Chapter 5). The analysis was able to demonstrate the prevalence of information quality in FM organisation as well as determining if the size or the structure of the organisation had a main effect on the quality of information. Based on the analysis, there was a high prevalence if information quality issue with a mean score of 7.89 and median score of eight. It was also observed that the score was distributed normally within the sample having a standard deviation score of 1.467 at 95% confidence level.

Further tests carried out to determine if the size or structure of the organisation had an effect on information quality using analysis of variance tests (ANOVA) which include a one-way ANOVA and a Factorial ANOVA (Two-way between groups ANOVA) demonstrated that the structure of the organisation had a significant effect on the quality of information, while the size of the organisation did not have a statistically significant effect on the quality of the organisation. This was in contrast to the result of Haug et al., (2013). However, it was observed from the analysis that the size of the organisation acted as a moderating factor on the structure of the organisation.

Based on the analysis, micro size organisation with a simple structure of two levels presented high information quality issue at the strategic level (Figure 5:28). As seen in Figure 5:28, the operational level experienced low levels of information quality issues across the different size organisation. However, information quality issues had similar levels of prevalence at the tactical and strategic levels for small, medium, and large organisations. In essence, this indicates that as the size of the organisation grows; its structural elaboration becomes more complex (i.e. having several layers) which in turn has an effect on the quality of information.

To summarise, the results from this analysis revealed that there is a very high prevalence of information quality issue in FM industry. In addition to this, the structure of the organisation (i.e. hierarchical levels) presents a main effect on IQ in FM organisation. However, uniquely, it was observed that the size of the organisation did not have any statistically significant effect on IQ but acted as a moderating factor in the influence of IQ.

7.2.3 RO3 – To Identify the Information Quality (IQ) Attributes Specific to Asset Management (AM) In Facilities Management Operations (FM)

This objective was achieved by means of a literature review and qualitative data analysis (see Chapter 2 and Chapter 4 . The method of qualitative data analysis adopted was thematic analysis. Evidence from the literature review indicated a proliferation of IQ attributes. However, these were not specific to FM. Going further, data from the interviewees was obtained and analysed to identify IQ attributes that were specific to AM in FM (see Chapter 4 and Appendix VI). The result presented IQ attributes, which had most references by participants in the study. In total 71 IQ attributes were determined from the interviews (Appendix VI). In addition to this, seven (7) quality attribute were deemed to be most important to the operations of the respondents due to the high levels of references made to those qualities (Table 4:5 and Figure 4:7). This was determined using a frequency distribution of the identified attribute as mentioned by the respondents during the interview analysis These include *accessible, accuracy, correct, current, detailed, timeliness,* and *visible*

7.2.4 RO4 – To Classify the Information Quality (IQ) Attributes Into Specific Information Quality (IQ) Dimensions within the Context of Asset Management (AM) In Facilities Management (FM)

This objective was achieved by using principal component analysis (PCA) with direct oblimin rotation which is a quantitative analysis technique. It was noted that there are more dimensions of IQ than as previously indicated from the literature, whereby the identified IQ dimensions based on the analysis closely approximate the real-world context. The output from the analysis revealed twelve (12) dimensions of information quality. These dimensions were further grouped into based on the contextual meaning of the dimensions (see Chapter 5).These dimensions specifically indicate which IQ attributes account for each IQ dimension (Figure 5:29). For instance, it was observed that the dimension “Volume” constitute the following IQ attributes; *Adequate, Appropriate Amount, Sufficient, Enough, Little,* while the “Scope” dimension constitute the following attributes; *Readable, Complete, Uniform, Comprehensive, Informed, Hierarchical, Mandatory, Fine-Tuned, Purpose, In-Depth, Parameters.*

An appropriate naming convention was further formulated to provide relevant terms to the identified groups of dimension derived from PCA. This was performed to ensure that the naming used in this study reflected the perspective of the operations, a contextual naming convention was instituted.

7.2.5 RO5 – Develop and Evaluate A Framework to Improve Information Quality (IQ) Of Asset Management (AM) Activities in Facilities Management (FM) Through Expert Groups

Finally, objective five (5) a framework was developed based on the results of the data analysis. The framework constituted a cause-and-effect diagram (Ishikawa fishbone diagram) and a perceptual map. The cause-and-effect diagram was well placed in this study because of its established role in quality management. The perceptual map was formulated to include the identified IQ dimensions whereby scores were attributed to each dimension based on subjective evaluation of its quality and the relative importance of the dimension to the operations. The framework was subsequently evaluated using expert opinion survey to determine it applicability in assessing IQ within an operational context. An evaluation questionnaire was developed based on the principles posited by Eppler & Wittig, (2000). Data from the questionnaire was subjected to further analysis using SPSS version 22 software package. The analytical technique adopted in this instance was descriptive where the mean, median, standard deviation and frequency statistic were computed. The framework achieved positive scoring at the analytic level with a cumulative mean score of 4.08 (Figure 6:12). However, the result from the analysis showed that there were areas of concern in the framework predominantly situated in the pragmatic (operational) level (Table 6:12) having a cumulative mean score of 3.21 (Figure 6:12). This concern related to the ability in interpreting the framework easily. The evidence from the analysis thus recommend that the framework be refined and further tested to enhance its suitability and adaptability.

7.3 Research Limitations

Despite the exhaustive and methodical approach applied to this research, it must by acknowledged that certain limitations does apply. However, this is a reflection on the degree to which the findings and conclusions can be said to be the truth (Saunders et al., 2012). The study adopts an interpretivist philosophical stance. This approach is subject to the researcher's axiological disposition which in the case of an interpretivist philosophical stance is value laden. Thus, the interpretation of the results is subject to the perception of the researcher. However, the context in which this study has been carried out and the identified problems which the research sought to resolve necessitated an interpretivist philosophy and does not preclude the robustness of the results. Based on this it can be acknowledged that new knowledge has been created, whereby this knowledge is applicable, based on the Knowledge Development (Figure 3:2), within the context it has been investigated. In addition to this, this research has been performed within the context of the BE, specifically in the discipline of facilities management. As such, the generalisation of the result and framework has been conducted within this boundary with small sample sizes which is a feature of mixed-method research. Thus the applicability of the output may not be guaranteed in other fields but should be tested rigorously to validate its usefulness.

A significant limitation of the research was the constraint imposed by the limited funds available for the study. This restricted the ability to conduct more interviews, by means of travel, in different geographical locations to elicit different opinions from potentially different participants. However, attempts to overcome this limitation was made by means of telephone conversations. This still elicited new and different challenges in the research such as the poor quality of the call connection, the background noise from other people, and the distinctive manner of oral expression (local accent) of the participants. This inadvertently made transcription from voice to text very difficult and time-consuming. As a further effect from the funding constraints, particular limitation was placed on the choices made in the research with regards to the sampling strategy adopted. This was made evident in the sampling of participants for the qualitative phase of the research where a small number was selected. However to mitigate this effect, it was pertinent to ensure that the selected sample participants were drawn from the different levels of the organisation to reflect the characteristics of a typical FM organisation. Finally, this study was time bound which further influenced the methodology of the study.

7.4 Research Contribution

As indicated in Chapter 1 this study sought to make significant contribution to both knowledge and industry. It aimed to address the limited amount of research in IQ within FM. This has been achieved by providing an empirical basis for assessing IQ of AM within FM discipline. It has demonstrated the suitability of using mixed method approach in which robust analytical techniques had been applied to identify what latent factors affect IQ and how these can be applied in a framework to improve IQ of AM.

To this effect, an extensive and detailed investigation of IQ has been performed to provide significant contribution to the existing body of knowledge relating to IQ affecting AM in FM operations. Achieving this has been facilitated by the use of robust analytical techniques that seeks to ensure the reliability and credibility of the results. Therefore, it can be noted here the following contributions have been made in this research:

1. Contribution to knowledge
    a. This research has provided an empirical basis for assessing IQ. From this, specific categories of IQ dimensions (12 IQ dimensions) have been identified based on the contextualisation of the phenomenon in the analysis section. This has been grouped into 7 categories to provide ease of interpretation. This forms the foundation to aid future analytical processes to be carried out within the particular context of the research to ascertain easily the effect of IQ within FM operation
    b. This research has applied techniques in the fields of quality management, and statistics in assessing IQ which are cause and effect (Ishikawa fish bone

diagram), perceptual map, principal component analysis (PCA) and analysis of variance (ANOVA). This demonstrates the applicability of the methods used in these areas in aiding the assessment of IQ in the AM. These techniques are able to provide a visual representation of the assessment of IQ which encourages ease of analysis.

2. Contribution to practice
    a. The research has developed a framework which encapsulates the processes that will enable the assessment of IQ by practitioners. These processes are have been considered easy to use based on the supporting tools accompanying the framework. The framework further enable practitioners in FM gain further insight into the issues surrounding IQ with a view to ameliorate the effect of poor IQ in AM.
    b. The framework can be used to support evidence-based IQ improvement strategies by practitioners.

7.5 Recommendations for Future Research

As a result of the methodical approach and identified limitations in this study, significant unique opportunity to in information quality research have emanated that can inform future research in this field. Some worthwhile areas that will expand the scope of this research will include: (1) extension of the methodological technique to other disciplines using an increased sample size, (2) in-depth evaluation of the framework to identify areas for improvement or modification, (3) the application of mathematical models e.g. linear model, regression method, or factor scores, to describe the IQ dimension scores in terms of the IQ attribute variable being measured, and (4) the development of an IQ database for assessing IQ in any operational context.

Appendix I Interview pro forma

SEMI-STRUCTURED INTERVIEW PRO-FORMA

University of Huddersfield

An Exploratory Study of Factors Influencing Asset Management Information Quality in Facilities Management Operations

Aim:

To Develop an Asset-Information Quality Management Framework to Improve Information Quality in Facility Management Operations

By

Ubon Martin Essiet

ubon.essiet@hud.ac.uk

@00319325

Supervisor: Prof. Song Wu <S.Wu@hud.ac.uk>

Interview Schedule

Title: *Investigating the Factors the Contribute to Poor Asset Information Quality.*

Date:

Venue:

Time:

Introduction: *(5-10 minutes)*

The interviewer will discuss the purpose of the study with the interviewee, which is “Investigating the Factors the Contribute to Poor Asset Information Quality”.

The interviewer will introduce themselves and ask the interviewee general questions about themselves. This will then be followed by a demographic survey (section 2; page 3 and 4) and research specific questions (section 3; page 6).

<u>Participant Survey Questionnaire</u>

Demographic Information

Please tick as appropriate (See guide below)

Title	Mr ☐	Mrs ☐	Miss ☐	Dr ☐	Others [Please Specify]:	
First Name						
Middle Name						
Last Name						
Gender	Male		☐			
	Female		☐			
Age Group	≤17 ☐	18 – 24 ☐	25 – 34 ☐		35 – 44 ☐	≥45 ☐
Highest Qualification	No Schooling Completed				☐	
	Some High School, No Diploma				☐	
	High School Graduate, Diploma Or The Equivalent				☐	
	Some College Credit, No Degree				☐	
	Trade/Technical/Vocational Training				☐	
	Associate Degree				☐	
	Bachelor’s Degree				☐	
	Master’s Degree				☐	
	Professional Degree				☐	
	Doctorate Degree				☐	
Organisation Department	Skanska Facilities Services					
Role or Position[27]	Energy Analyst					
Level In Organisation	Strategic		☐			
	Tactical		☐			
	Operational		☐			
Years In Service	≤1 ☐	2-5 ☐	6-10☒	11-15 ☐	≥16 ☐	

Organisation Information

Please state or tick as appropriate (See guide below)

Name of Organisation[28]	
Type of Organisation[29]	

[27] Role or Position: This is the title help by the participant or function performed by the participant

[28] Name of Organisation: This is the name of the organisation or project under study

[29] Type of Organisation: This is the characteristic of the organisation or project e.g. hospital, office, shop, school etc.

Size of Organisation[30]					
Industry of Organisation[31]					
Years In Operation[32]	≤1 ☐	2-5 ☐	6-10☐	11-15 ☐	≥16 ☐

Conduct of Interview and Main Themes

Preliminary Questions: *(5 minutes)*

Research specific themes to be discussed are as follows:

1. Asset management
    a. Awareness
    b. Benefits
    c. Practice
2. Information Quality
3. Cause and effect of poor information quality

Conduct of interview / Main Themes: *(30-60 minutes; 5 minutes per question and an extra 10 minutes if necessary). The interview will focus on the following themes:*

1. Information Perspective (information manufacturing)
    a. Information inputs and quality factors (information quality dimensions) – data sources
    b. Asset information management – systems of use
    c. Information outputs and quality – information products

2. Organisational Perspective (information utilisation)
    a. Established and referenced processes for asset information collection, management and analysis
    b. Decision making and analysis
        i. Cost and Risk control
        ii. Lifecycle analysis
        iii. Budgets
        iv. Others
    c. Performance, measurement, management and control criteria/dimension

3. People Perspective (influence of skills, motivation, training, etc. on asset information quality)

[30] Size of Organisation: this indicates total number of employees (approximate values are acceptable) engaged in the organisation or project
[31] Industry of Organisation: Service, Construction, Manufacturing, Health Care, Retail
[32] This indicates the duration or period that the organisation has been operating

a. Information consumers: people or groups who are involved in information utilisation process which may involve aggregation, integration, decision making, etc.
b. Information custodians: people who provide and manage computing resources such as data storage, maintenance, integration, security
c. Information producers: people groups or other sources who are associated with information generation process

Conclusion

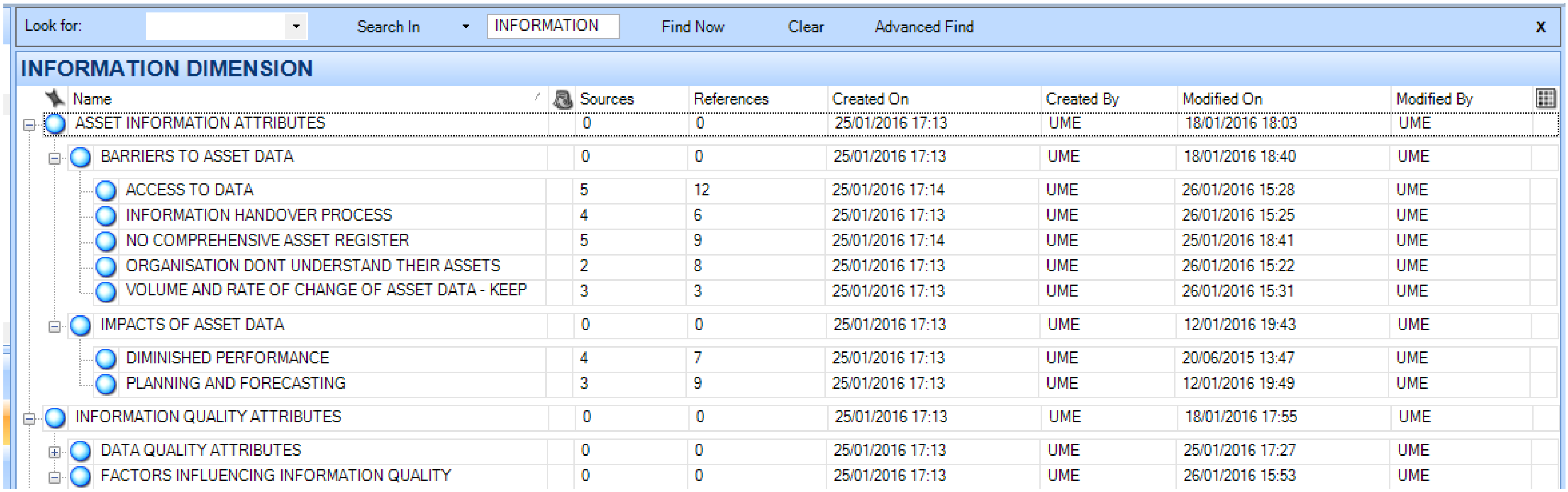
Conclusion: *(5 minutes)*

This entails a debriefing session, asking the participant if there is anything else they would like to add and asking are they happy with the interview. The interviewer can answer any questions in this section and ensure the participant understands the purpose of the study and what will happen with the findings.

Thank you for your time and participation.

(*all times are approximate, to be used as a guideline, as some sections will not take the allocated times.)

Appendix II NVivo Screenshot



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INFORMATION DIMENSION

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ACCESS TO DATA	5	12	25/01/2016 17:14	UME	26/01/2016 15:28	UME
INFORMATION HANDOVER PROCESS	4	6	25/01/2016 17:13	UME	26/01/2016 15:25	UME
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ORGANISATION DONT UNDERSTAND THEIR ASSETS	2	8	25/01/2016 17:13	UME	26/01/2016 15:22	UME
VOLUME AND RATE OF CHANGE OF ASSET DATA - KEEP	3	3	25/01/2016 17:13	UME	26/01/2016 15:31	UME
IMPACTS OF ASSET DATA	0	0	25/01/2016 17:13	UME	12/01/2016 19:43	UME
DIMINISHED PERFORMANCE	4	7	25/01/2016 17:13	UME	20/06/2015 13:47	UME
PLANNING AND FORECASTING	3	9	25/01/2016 17:13	UME	12/01/2016 19:49	UME
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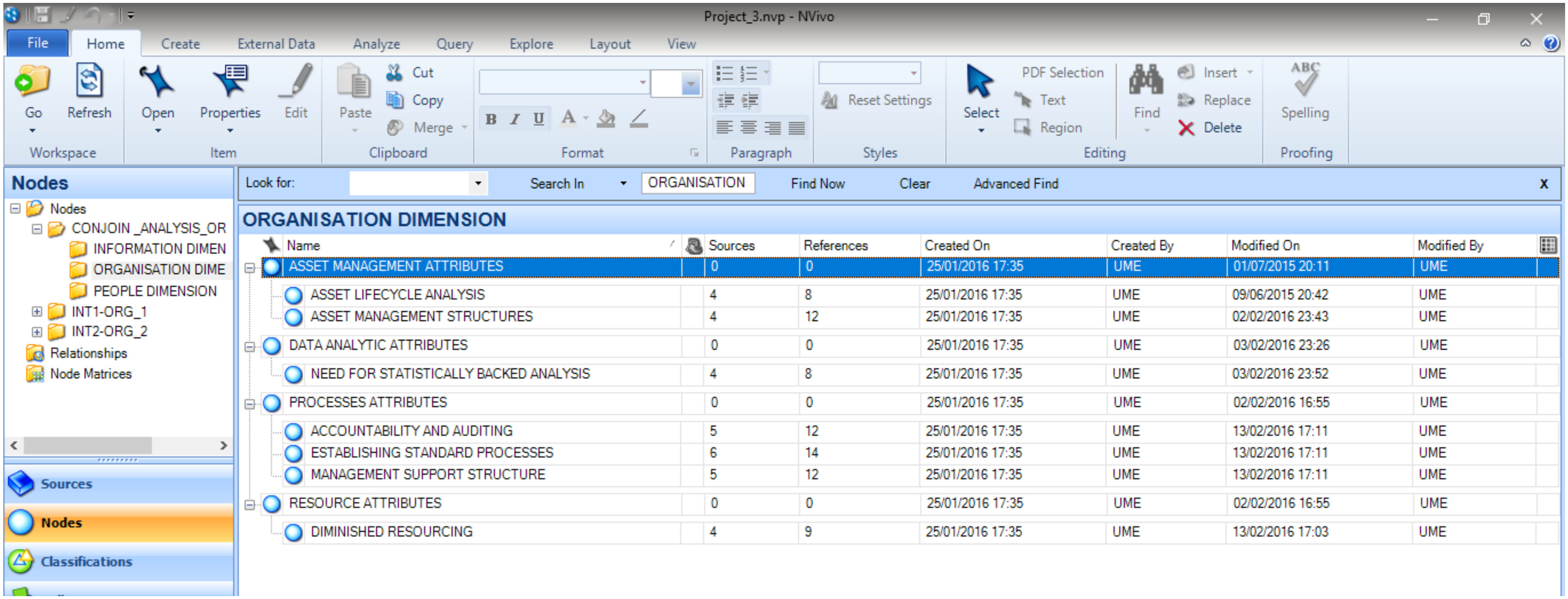
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ESTABLISHING STANDARD PROCESSES 6 14 25/01/2016 17:35 UME 13/02/2016 17:11 UME
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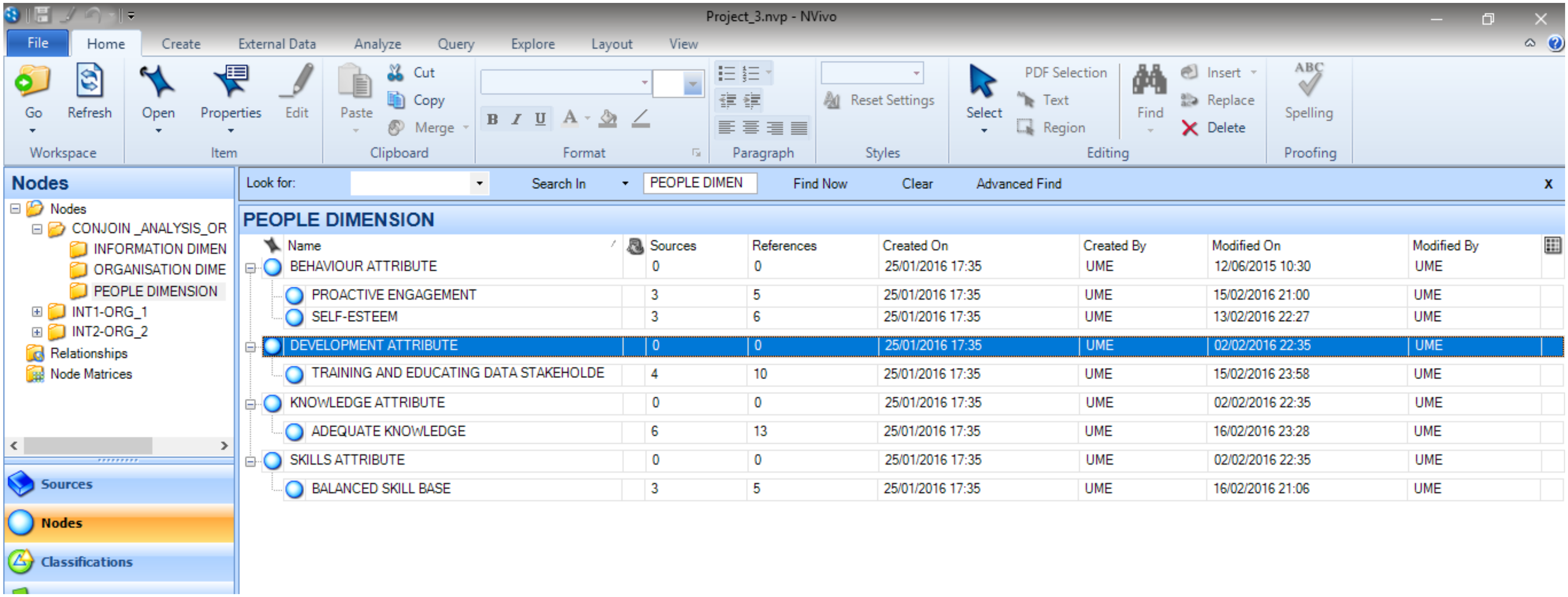

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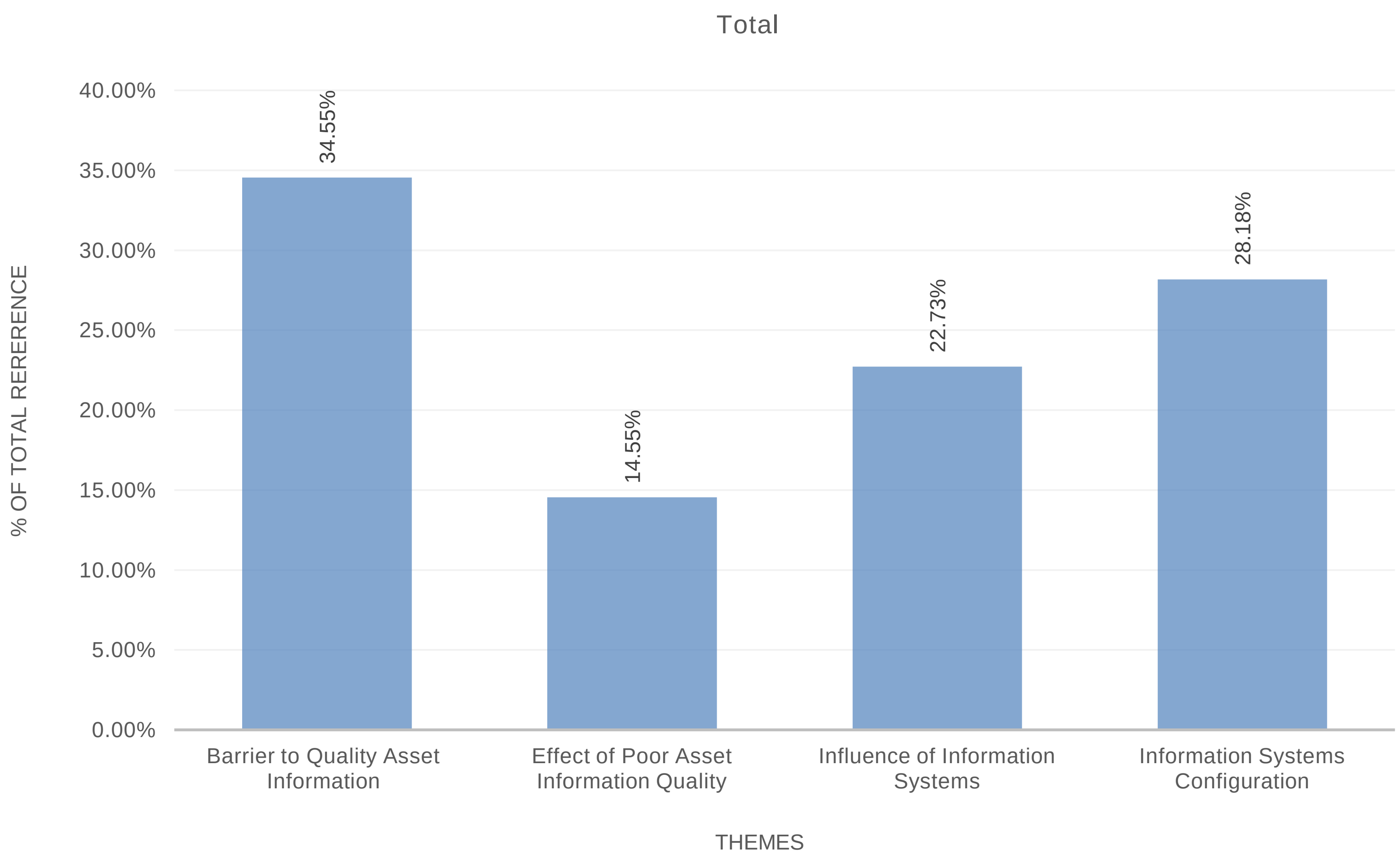
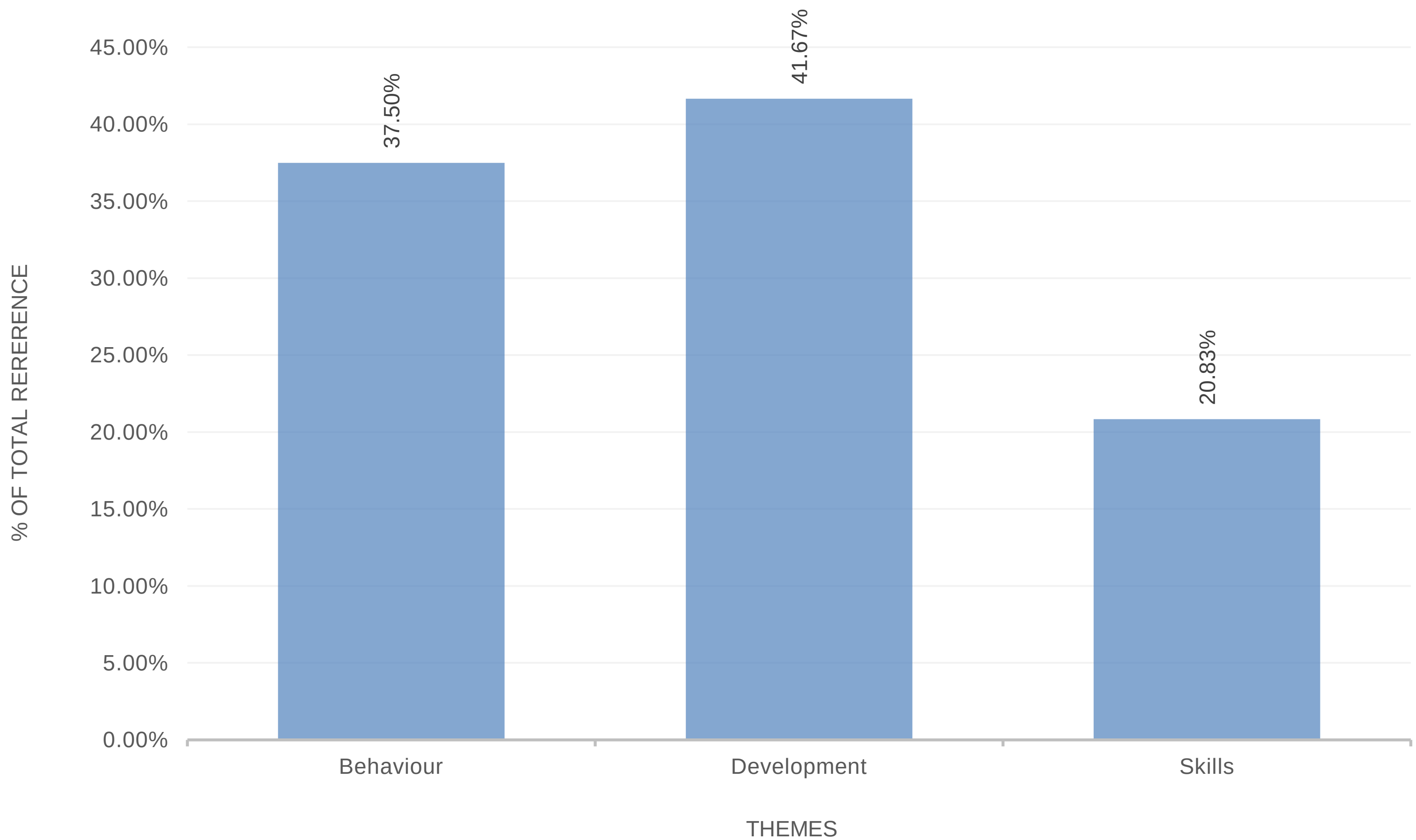
ADEQUATE KNOWLEDGE 6 13 25/01/2016 17:35 UME 16/02/2016 23:28 UME
SKILLS ATTRIBUTE 0 0 25/01/2016 17:35 UME 02/02/2016 22:35 UME
BALANCED SKILL BASE 3 5 25/01/2016 17:35 UME 16/02/2016 21:06 UME

Appendix III Summary Bar Chart of Thematic Analysis for Information Domain



Appendix IV Summary Bar Chart of Thematic Analysis for Organisational Domain

Appendix V   Summary Bar Chart of Thematic Analysis for People Domain



Appendix VI Percentage (%) Relative Frequency of Occurrence of IQ Attributes

No	Data Quality Attributes	Total Frequency References	Relative Frequency	% Relative Frequency	Cumm Frequency	% Cumm Frequency
1	ACCESSIBLE	9	0.04	4.27	9	4.27
2	ACCURACY	21	0.10	9.95	30	14.22
3	AVAILABLE	2	0.01	0.95	32	15.17
4	AWARE	1	0.00	0.47	33	15.64
5	BENCHMARK	1	0.00	0.47	34	16.11
6	BEST	1	0.00	0.47	35	16.59
7	CHAOTIC	1	0.00	0.47	36	17.06
8	CLARITY	1	0.00	0.47	37	17.54
9	COLLABORATIVE	1	0.00	0.47	38	18.01
10	COMPLETE	4	0.02	1.90	42	19.91
11	COMPREHENSIVE	1	0.00	0.47	43	20.38
12	CONFIDENT	1	0.00	0.47	44	20.85
13	CONSISTENT	4	0.02	1.90	48	22.75
14	CORRECT	8	0.04	3.79	56	26.54
15	CURRENT	8	0.04	3.79	64	30.33
16	DAILY	1	0.00	0.47	65	30.81
17	DETAILED	15	0.07	7.11	80	37.91
18	DIRECTED	1	0.00	0.47	81	38.39
19	ENOUGH	6	0.03	2.84	87	41.23
20	FINE-TUNED	1	0.00	0.47	88	41.71
21	FORM	1	0.00	0.47	89	42.18
22	FORMAT	6	0.03	2.84	95	45.02
23	FULL	1	0.00	0.47	96	45.50
24	GAP	1	0.00	0.47	97	45.97
25	GENERIC	3	0.01	1.42	100	47.39
26	GOOD	6	0.03	2.84	106	50.24
27	GRANULAR	1	0.00	0.47	107	50.71
28	HIERARCHICAL LEVEL	4	0.02	1.90	111	52.61
29	HISTORICAL	1	0.00	0.47	112	53.08
30	HOLISTIC	3	0.01	1.42	115	54.50
31	IN-DEPTH	2	0.01	0.95	117	55.45

32	INFORMED	1	0.00	0.47	118	55.92
33	INTERROGATORY	2	0.01	0.95	120	56.87
34	LACK	1	0.00	0.47	121	57.35
35	LITTLE	6	0.03	2.84	127	60.19
36	MANAGE	1	0.00	0.47	128	60.66
37	MANDATORY	1	0.00	0.47	129	61.14
38	MANIPULATE	1	0.00	0.47	130	61.61
39	ORGANISED	1	0.00	0.47	131	62.09
40	OVERLOAD	2	0.01	0.95	133	63.03
41	PARAMETERS	2	0.01	0.95	135	63.98
42	PERCEPTION	1	0.00	0.47	136	64.45
43	PERFECT	1	0.00	0.47	137	64.93
44	PERSONALIZE	2	0.01	0.95	139	65.88
45	PLAIN	2	0.01	0.95	141	66.82
46	PRESENTATION	1	0.00	0.47	142	67.30
47	PRIORITY	2	0.01	0.95	144	68.25
48	PROTECTED	1	0.00	0.47	145	68.72
49	PURPOSE	3	0.01	1.42	148	70.14
50	RAW	1	0.00	0.47	149	70.62
51	READABLE	1	0.00	0.47	150	71.09
52	RELAYED	1	0.00	0.47	151	71.56
53	RELEVANCE	2	0.01	0.95	153	72.51
54	SENSITIVE	1	0.00	0.47	154	72.99
55	SHARING	2	0.01	0.95	156	73.93
56	SOURCE	1	0.00	0.47	157	74.41
57	STANDARDIZED	5	0.02	2.37	162	76.78
58	STREAMLINED	1	0.00	0.47	163	77.25
59	STRUCTURED	4	0.02	1.90	167	79.15
60	SUFFICIENT	5	0.02	2.37	172	81.52
61	SUPPLEMENTARY	3	0.01	1.42	175	82.94
62	TIMELINESS	8	0.04	3.79	183	86.73
63	TRUSTWORTHY	2	0.01	0.95	185	87.68
64	UNDERSTAND	7	0.03	3.32	192	91.00
65	UNIFORM	1	0.00	0.47	193	91.47
66	UP-TO-DATE	2	0.01	0.95	195	92.42
67	USE	1	0.00	0.47	196	92.89
68	VALUE	2	0.01	0.95	198	93.84
69	VARIETY	1	0.00	0.47	199	94.31

70	VERIFIABLE	4	0.02	1.90	203	96.21
71	VISIBILE	8	0.04	3.79	211	100.00
	TOTAL	211	1.00	100.00		

χ^2 (Chi-Squared) Distribution: Critical Values of χ^2

Degrees of freedom	5%	1%	0.1%
	Significance level		
1	3.841	6.635	10.828
2	5.991	9.210	13.816
3	7.815	11.345	16.266
4	9.488	13.277	18.467
5	11.070	15.086	20.515
6	12.592	16.812	22.458
7	14.067	18.475	24.322
8	15.507	20.090	26.124
9	16.919	21.666	27.877
10	18.307	23.209	29.588

Appendix VIII   Questionnaire

STRUCTURED QUESTIONNARIE

An Exploratory Study of Factors Influencing Asset Management Information Quality in Facilities Management Operations

It is recognised that the use of high-quality information in decision-making about risk, performance and costs with specific reference to capital and operational expenditure is crucial in asset management programs. However, there are numerous challenges presented to the facilities manager in achieving this efficiently due to information quality issues. Not much attention has been paid to improving information quality in FM. Evidence suggest that research in information quality for effective asset management by FM is negligible. This study argues that information quality influences the outcomes of asset management programs. It also argues that for FM to add value to the clients it serves the issues of information quality is to be taken serious. Thus this study aims to develop a framework to improve information quality by investigating the influence of information quality on asset management programs in FM operations.

*Required

Consent

This section is aimed at obtaining your consent to participate in the study. All information you provide will be confidential and in accordance with The Data Protection Act 1998 (UK Legislation, 1998). The following will apply to data and information you provided in this study:

1. All data and information obtained from this research will comply with the Data Protection Act of 1998 (http://www.legislation.gov.uk/ukpga/1998/29/schedule/1).
2. All participant data shall be anonymised and will use higher levels of data aggregation to remove personal identifiers.
3. An assurance of confidentiality and anonymity will be guaranteed through the use of pseudonyms and appropriate secure data storage.
4. Sensitive and personal data which contains information about but not limited to gender, ethnic origin, trade union, political opinions, etc., shall be processed subject to the conditions in schedule 3 of the 1998 Data Protection Act (http://www.legislation.gov.uk/ukpga/1998/29/schedule/3).
5. Electronic data will password protected and encrypted and where applicable, all paper–based data shall be stored in locked filing cabinet.
6. Files containing confidential and personal data which include but not limited to paper copies of interviews, observation notes, signed consent forms, structured observation

forms, questionnaires, transcriptions and other documents, shall be labelled properly and securely kept in a locked cabinet. Access to this cabinet will be by the researcher only.

7. Data held on external hard disc drives, compact discs, USB drives, audio recorders will also be held under the same conditions in 6. As such, particular care will be taken for data held on laptop computers or on removable storage media such as memory sticks, CD/DVDs, portable hard drives, etc.
8. Data held on computer hard drives will be protected with the use of a secure password which shall contain alphanumeric characters and special symbols. Primary and secondary security encryption will be utilised on such devices. The computer(s) on which the data is stored shall be protected using a secure firewall and network protection software (antivirus).
9. Any personally identifying data will be removed as soon as is practicable once the study is completed. This will involve shredding data of individuals held on paper and permanently deleting of digital materials and copies.
10. I shall discuss and agree with the participant(s), where applicable and possible, on all available and appropriate methods to protect the identity (is) of the participant in any published results. For instance, this will include but not limited to using a coding system, through the use of pseudonyms and data aggregation to remove personal identifiers.

I have read and understood the information about the research, and I consent to participate in this study

Completing the questionnaire is voluntary, but we do hope you take part (Mark only one oval)

- ○ Yes
- ○ No [Stop filling out this form.]

FM Demographic Survey

This section collects generic information about the nature of the FM Industry. The purpose of this section is to learn more about the population's characteristics for the purpose of this research. This will inform the analysis within the context of information quality based on the information provided. For more information about surveys visit: https://www.gov.uk/service-manual/user-centred-design/user-research/survey-design.html

1. Gender * (Mark only one oval)

- ○ Male
- ○ Female
- ○ Prefer Not to Say
- ○ Others

2. Which age range do you belong to? * (Mark only one oval)

- ◉ 18 - 20

- 21 - 25
- 26 - 30
- 31 - 35
- 36 - 40
- 41 - 45
- 46 - 50
- 51 - 55
- 56 - 60
- 61 and above
- Prefer not to answer

3. What is the highest academic qualification you have achieved? *

This details the level of academic or professional qualification achieved based on the National Qualifications Framework https://www.gov.uk/what-different-qualification-levels-mean/compare-different-qualification-levels

(Mark only one oval)

- None
- Entry level
- Level - 1: GCSE (grades DG), Key Skills level 1, NVQ level 1, Foundation diploma
- Level - 2: GCSE (grades A*C), Key Skills level 2, NVQ level 2, Higher diploma
- Level - 3: AS and A level, NVQ level 3, Advanced diploma
- Level - 4: Certificate of higher education, HNC
- Level - 5: Diploma of higher education, Diploma of further education, Foundation degree, HND
- Level - 6: Bachelor’s degree, Graduate certificate, Graduate diploma
- Level - 7: Master’s degree, Postgraduate certificate, Postgraduate diploma
- Level 8: Doctorate
- Prefer not to answer
- Other (Please state below)

4. How many years of experience in do you have in facilities or/and asset management? *

(Mark only one oval)

- 0 - 1
- 2 - 5
- 6 - 10
- 11 and above

5. What is your primary job function?

6. What level in organisation do you belong to? * (Mark only one oval)

- Strategic
- Tactical
- Operational

7. What is the average size (total number of staff) of your organisation? * (Mark only one oval)

- 0 - 10
- 11 - 50
- 51 - 250
- 251 and above

8. Please provide your email address

(This information is confidential and in accordance with the data protection act (see consent section above). It will not be attached to the results, and no relationship will be established. If you would prefer not to answer this, please feel free to leave it blank)

Information Quality Dimension Questionnaire

The objective of this section is to identify and classify the information quality dimensions specific to facilities management operations. The following is a list of adjectives or phrases which describes information quality attributes. When answering the questions, please think about the information that is generated and used in your operations e.g. maintenance data, management data, customer data, accounting data, financial data, work order, parts data, GIS data, etc. to make decisions in your job.

Although the questions may seem repetitive, your response to each question is critical to the success of the study. Please give us the first response that comes to mind and try to use the full-scale range available. Apologies for the tedious nature of the survey.

1. On a scale of 1 to 10, how prevalent is the issue of information quality in your operations *
   (Mark only one oval)

	0	1	2	3	4	5	6	7	8	9	10	
Low	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	High

2. Please rate the importance of the following information quality attribute to your job

1 = Least Importance, 2 = Low Importance, 3 = Moderate Importance, 4 = Very Important, 5 = Extremely Important

(Mark only one oval per row)

Information Quality Attribute	1	2	3	4	5
Accessible	◯	◯	◯	◯	◯
Accurate	◯	◯	◯	◯	◯
Adequate	◯	◯	◯	◯	◯
Appropriate Amount	◯	◯	◯	◯	◯
Auditable	◯	◯	◯	◯	◯
Available	◯	◯	◯	◯	◯
Believability	◯	◯	◯	◯	◯
Best Quality	◯	◯	◯	◯	◯
Collaborative	◯	◯	◯	◯	◯
Compatible	◯	◯	◯	◯	◯
Complete	◯	◯	◯	◯	◯
Comprehensive	◯	◯	◯	◯	◯
Confident	◯	◯	◯	◯	◯
Consistent	◯	◯	◯	◯	◯
Correct	◯	◯	◯	◯	◯
Cost Effectiveness	◯	◯	◯	◯	◯
Detailed	◯	◯	◯	◯	◯
Directed	◯	◯	◯	◯	◯
Ease of Operation e.g. Downloading	◯	◯	◯	◯	◯
Ease of Understanding	◯	◯	◯	◯	◯
Easily Manipulated	◯	◯	◯	◯	◯
Enough	◯	◯	◯	◯	◯
Familiarity	◯	◯	◯	◯	◯
Fine-Tuned	◯	◯	◯	◯	◯
Flexibility	◯	◯	◯	◯	◯
Format	◯	◯	◯	◯	◯
Frequency	◯	◯	◯	◯	◯
Full	◯	◯	◯	◯	◯

Gap Free					
Generic					
Good					
Granular					
Hierarchical					
Historical					
In-Depth					
Informed					
Interoperable					
Interpretability					
Interrogatory					
Little					
Manageable					
Mandatory					
Measured Against a Set Standard					
Methodical					
Objectivity					
Organized					
Parameters					
Perception					
Perfect					
Personalized					
Plain					
Presentation					
Priority					
Protected					
Purpose					
Raw					
Readable					
Relevance					
Representational					
Reputation					
Robust					
Secure					
Sensitive					
Shareable					
Source					
Standardized					
Streamlined					
Structured					
Sufficient					

Supplementary	○	○	○	○	○
Timeliness	○	○	○	○	○
Traceability	○	○	○	○	○
Transmitted Seamlessly	○	○	○	○	○
Trustworthy	○	○	○	○	○
Understand	○	○	○	○	○
Uniform	○	○	○	○	○
Updated	○	○	○	○	○
Value	○	○	○	○	○
Variety	○	○	○	○	○
Verifiable	○	○	○	○	○
Visible	○	○	○	○	○
Well-Presented And Organised	○	○	○	○	○

You have reached the end of this survey. Thank you

Please ensure that all required questions are answered. Click back to review and change your response if you wish to do so before submitting. When you are done, click submit to send your form.

Appendix IX Information Quality Attributes Grouped by Dimensions Quality – Collated from Literature

No	Dimension	Dimension Meaning (Synonym or Phrase)	Attribute	Attribute Meaning (Synonym or Phrase)
1	Accessibility	The quality and attribute of being at hand when needed and easy to meet or deal with	Accessible	The information is easily retrievable with minimal restrictions
2			Collaborative	Can be used easily to work, one with another in a cooperative
3			Protected	Kept safe or defended from danger, injury, or loss.
4			Secure	Access security information cannot be accessed by competitors or are of proprietary nature or located in a restricted location
5			Shareable	Information can be used jointly or in common easily
6			Source	This refers to the reliance or quality of the origin or place from which information comes, arises, or is obtained from
7			Source	The document or organisation from which information is obtained is reliable
8			Visible	Noting or pertaining to a system of keeping records or information in such a way that the desired reference can be brought instantly to view
9	Availability	The quality of being at hand when needed	Appropriate Amount	Information is not overloaded, not too much information for use
10			Available	Suitable or ready for use for service or activity at hand
11			Consistent	Information constantly adhering to the same principles, course, form
12			Hierarchical	Broken down into relevant levels of context, understanding or scope

13	Content	Everything that is included in a collection and that is held or included in something	Accurate	The information are certified error free and flawless
14			Adequate	The information is as much or as good as necessary for some requirement or purpose; fully sufficient, suitable, or fit
15			Best Quality	The information is of the highest quality, excellence, or standing
16			Complete	There is enough breadth, depth and scope of information for decision-making
17			Comprehensive	All-inclusive information of large scope covering or involving much
18			Directed	This means that it goes to the right person, department, units or role
19			Enough	Sufficient for the purpose and as much as necessary
20			Fine-Tuned	Well adjusted for the right purpose
21			Full	Completely containing all the elements is needs to have
22			Gap Free	Devoid of gaps in transmission or frequency, consistent
23			Generic	Free of complexity or technicality
24			Good	Having the normally expected amount, desirable or positive qualities especially those suitable for a thing specified.
25			In-Depth	Extensive, thorough, or profound
26			Interpretability	The ability to give or provide the meaning of a situation
27			Little	Short in duration; not extensive; short; brief
28			Mandatory	Not to be disregarded or modified permitting no option
29			Organized	Devoid of chaos
30			Parameters	Having the right limits or boundaries and guidelines for effective operation
31			Perfect	Conforming absolutely to the description or definition of an ideal type

32			Plain	Clear or distinct to the view of the user, the mind and conveying the meaning clearly and simply. Easily understood
33			Purpose	Having meaning through having an aim. Information is full of meaning significant
34			Readable	Easily deciphered without complication
35			Relevance	The information is relevant, applicable and usable to the operations
36			Sufficient	Information is adequate for the purpose, activity or function
37			Supplementary	Information added to complete or make up a deficiency
38			Uniform	Identical or consistent, as from example to example, place to place, or moment to moment: without variations in detail
39			Value	Value added – information give you a competitive edge and adds value to your operations
40			Variety	There are more than one source of accessing information
41	Cost	Value measured by what must be given, done or undergone to obtain something. The property of having material worth (often indicated by the amount of money something would bring if sold)	Cost Effectiveness	Cost of information collection, extraction, transformation, loading and storage
42	Effectiveness	Power to be effective; the quality of being able to bring about an effect	Compatible	Information is compatible with other forms of information
43			Ease of Operation e.g. Downloading	Easily joined, changed, downloaded, referenced, aggregated, reproduced and customised
44			Easily Manipulated	Manipulable Capable of or susceptible to being manipulated and transformed especially for use in statistical analysis
45			Flexibility	Easily adaptable
46			Interoperable	Capable of being used or operated reciprocally

47			Manageable	Ability to be handled effectively and successful to achieve a goal. To bring about or succeed in accomplishing, sometimes despite difficulty or hardship
48			Methodical	Information collected, disposed, or acting in a systematic or orderly way to reduce errors
49			Robust	Strong and effective enough in all or most situations and conditions to withstand or overcome intellectual challenges or adversity
50			Transmitted Seamlessly	Relayed: Seamless passing of information along from one person or group to another
51	Form	The spatial arrangement of something as distinct from its substance as well as The visual appearance of something or someone	Detailed	Extended treatment of the information particulars
52			Ease of Understanding	The information is clearly understood
53			Familiarity	This means awareness with the information used for operations or activity
54			Format	The organisation of information according to preset specifications
55			Granular	Highly detailed; having many small and distinct parts useful for detailed information analysis and information mining for decision-making
56			Informed	Be able to impart knowledge of some fact, state or affairs, or event to. Having or prepared with information or knowledge
57			Perception	Immediate or intuitive recognition or appreciation
58			Personalized	Made for or directed or adjusted to a particular individual, purpose or situation
59			Presentation	The organisation of visual details to create an overall impression to the user of information

60			Raw	Information not having undergone detailed processes of preparing, finishing, refining, or manufacture
61			Representational	Information represents the scope of operations or activity performed
62			Streamlined	Information is designed or arranged to offer the least resistant and made efficient and compact by stripping off nonessentials
63			Structured	Information is considered from the point of view of the whole rather than of any single part. Having definite and highly organised structure
64			Understand	Know and comprehend the nature or meaning of, to perceive the meaning of; grasp the idea of; comprehend
65			Well-Presented And Organised	Concise Representation: Well-presented and organised
66	Time	The continuum of experience in which events pass from the future through the present to the past	Frequency	Comes at regular intervals
67			Historical	Used for the study of a phenomenon as it changes through time
68			Priority	The state or quality of being earlier in time or occurrence especially for mission critical activities
69			Timeliness	Age of the information. Arrives at the right time
70			Updated	To incorporate new or more accurate information in a particular subject
71	Validity	The quality of being well grounded in logic or truth or having legal force, rigorous and being logical	Auditable	Ease of inspection or examination of information and its facility to evaluate or improve its appropriateness, safety, efficiency, or the like

72			Believability	To have confidence in the truth, the existence, or the reliability of information
73			Confident	Not liable to error in judgment or action or having strong belief or full assurance
74			Correct	To be in accordance with a standard or with a required condition
75			Interrogatory	The ability to express or involve a question in answering specific problem
76			Measured Against a Set Standard	Information quality can be Benchmarked, Measured against a set standard
77			Objectivity	The information is unbiased and non-subjective
78			Reputation	Refers to the reputation of the source of information
79			Sensitive	Readily or excessively affected by external agencies or influences
80			Standardized	The information is capable of replacing or changing places with something else permitting mutual substitution without loss of function or suitability
81			Traceability	Information is well documented and verifiable
82			Trustworthy	Deserving of trust or confidence; dependable; reliable
83			Verifiable	The ease of ascertaining the truth or correctness of the information by examination, research, or comparison

Appendix X   Contextual Information Quality Dimensions

IQ Dimension Cluster	Dimension	Attributes	Meaning of Attribute
Dependable	Reputation	Measured Against a Set Standard	Information quality can be benchmarked, measured against a set standard
		Interrogatory	The ability to express or involve a question in answering specific problem
		Sensitive	Readily or excessively affected by external agencies or influences
		Reputation	Refers to the reputation of the source of information
		Standardized	The information is capable of replacing or changing places with something else permitting mutual substitution without loss of function or suitability
		Traceability	Information is well documented and verifiable
		Objectivity	The information is unbiased and non-subjective
	Validity	Objectivity	The information is unbiased and non-subjective
		Correct	To be in accordance with a standard or with a required condition
		Auditable	Ease of inspection or examination of information and its facility to evaluate or improve its appropriateness, safety, efficiency, or the like
		Trustworthy	Deserving of trust or confidence; dependable; reliable
		Confident	Not liable to error in judgment or action or having strong belief or full assurance
		Verifiable	The ease of ascertaining the truth or correctness of the information by examination, research, or comparison
		Believability	To have confidence in the truth, the existence, or the reliability of information
Security	**Accessibility**	Source	This refers to the reliance or quality of the origin or place from which information comes, arises, or is obtained from
		Accessible	The information is easily retrievable with minimal restrictions
		Shareable	Information can be used jointly or in common easily
		Collaborative	Can be used easily to work, one with another in a cooperative
		Compatible	Information is compatible with other forms of information

	Available	**Visible**	Noting or pertaining to a system of keeping records or information in such a way that the desired reference can be brought instantly to view
		Protected	Kept safe or defended from danger, injury, or loss.
		Available	Suitable or ready for use for service or activity at hand
		Secure	Access security information cannot be accessed by competitors or are of proprietary nature or located in a restricted location
Operational	Effectiveness	Value	Value added – information give you a competitive edge and adds value to your operations
		Gap Free	Devoid of gaps in transmission or frequency, consistent
		Streamlined	Information is designed or arranged to offer the least resistant and made efficient and compact by stripping off nonessentials
		Transmitted Seamlessly	Relayed: seamless passing of information along from one person or group to another
		Flexibility	Easily adaptable
		Ease of Operation	Easily joined, changed, downloaded, referenced, aggregated, reproduced and customised
		Interoperable	Capable of being used or operated reciprocally
		Manageable	Ability to be handled effectively and successful to achieve a goal. To bring about or succeed in accomplishing, sometimes despite difficulty or hardship
	Robustness	Methodical	Information collected, disposed, or acting in a systematic or orderly way to reduce errors
		Easily Manipulated	Manipulable capable of or susceptible to being manipulated and transformed especially for use in statistical analysis
		Robust	Strong and effective enough in all or most situations and conditions to withstand or overcome intellectual challenges or adversity
		Organized	Devoid of chaos
		Granular	Highly detailed; having many small and distinct parts useful for detailed information analysis and information mining for decision-making
Usable	**Content**	Generic	Free of complexity or technicality
		Good	Having the normally expected amount, desirable or positive qualities especially those suitable for a thing specified.
		Perfect	Conforming absolutely to the description or definition of an ideal type
		Best Quality	The information is of the highest quality, excellence, or standing
		Full	Completely containing all the elements is needs to have
		Supplementary	Information added to complete or make up a deficiency

		Directed	This means that it goes to the right person, department, units or role
		Interpretability	The ability to give or provide the meaning of a situation
		Accurate	The information are certified error free and flawless
		In-Depth	Extensive, thorough, or profound
		Parameters	Having the right limits or boundaries and guidelines for effective operation
	Scope	Relevance	The information is relevant, applicable and usable to the operations
		Readable	Easily deciphered without complication
		Complete	There is enough breadth, depth and scope of information for decision-making
		Uniform	Identical or consistent, as from example to example, place to place, or moment to moment: without variations in detail
		Comprehensive	All-inclusive information of large scope covering or involving much
		Informed	Be able to impart knowledge of some fact, state or affairs, or event to. Having or prepared with information or knowledge
		Hierarchical	Broken down into relevant levels of context, understanding or scope
		Mandatory	Not to be disregarded or modified permitting no option
		Fine-Tuned	Well adjusted for the right purpose
		Purpose	Having meaning through having an aim. Information is full of meaning significant
		In-Depth	Extensive, thorough, or profound
		Parameters	Having the right limits or boundaries and guidelines for effective operation
Aesthetic	Visualisation	Plain	Clear or distinct to the view of the user, the mind and conveying the meaning clearly and simply. Easily understood
		Personalized	Made for or directed or adjusted to a particular individual, purpose or situation
		Structured	Information is considered from the point of view of the whole rather than of any single part. Having definite and highly organised structure
		Presentation	The organisation of visual details to create an overall impression to the user of information
		Representational	Information represents the scope of operations or activity performed
		Ease Of Understanding	The information is clearly understood
		Familiarity	This means awareness with the information used for operations or activity
		Perception	Immediate or intuitive recognition or appreciation
	Form	Familiarity	This means awareness with the information used for operations or activity
		Perception	Immediate or intuitive recognition or appreciation
		Readable	Easily deciphered without complication

		Understand	Know and comprehend the nature or meaning of, to perceive the meaning of; grasp the idea of; comprehend
		Detailed	Extended treatment of the information particulars
		Consistent	Information constantly adhering to the same principles, course, form
		Format	The organisation of information according to preset specifications
		Well-Presented And Organised	Concise representation: well-presented and organised
Currency	**Time**	Priority	The state or quality of being earlier in time or occurrence especially for mission critical activities
		Frequency	Comes at regular intervals
		Updated	To incorporate new or more accurate information in a particular subject
		Historical	Used for the study of a phenomenon as it changes through time
		Timeliness	Age of the information. Arrives at the right time
Volume	Volume	Adequate	The information is as much or as good as necessary for some requirement or purpose; fully sufficient, suitable, or fit
		Appropriate Amount	Information is not overloaded, not too much information for use
		Sufficient	Information is adequate for the purpose, activity or function
		Enough	Sufficient for the purpose and as much as necessary
		Little	Short in duration; not extensive; short; brief

Appendix XI Perceptual Map Assessment Worksheet (Screenshot)

Simply type over the grey cells below to quickly and easily create your own Perceptual Map

Step 1 **Enter the Title of Your Map** — FM Operations IQ MEASURE
(Type over this map title.)

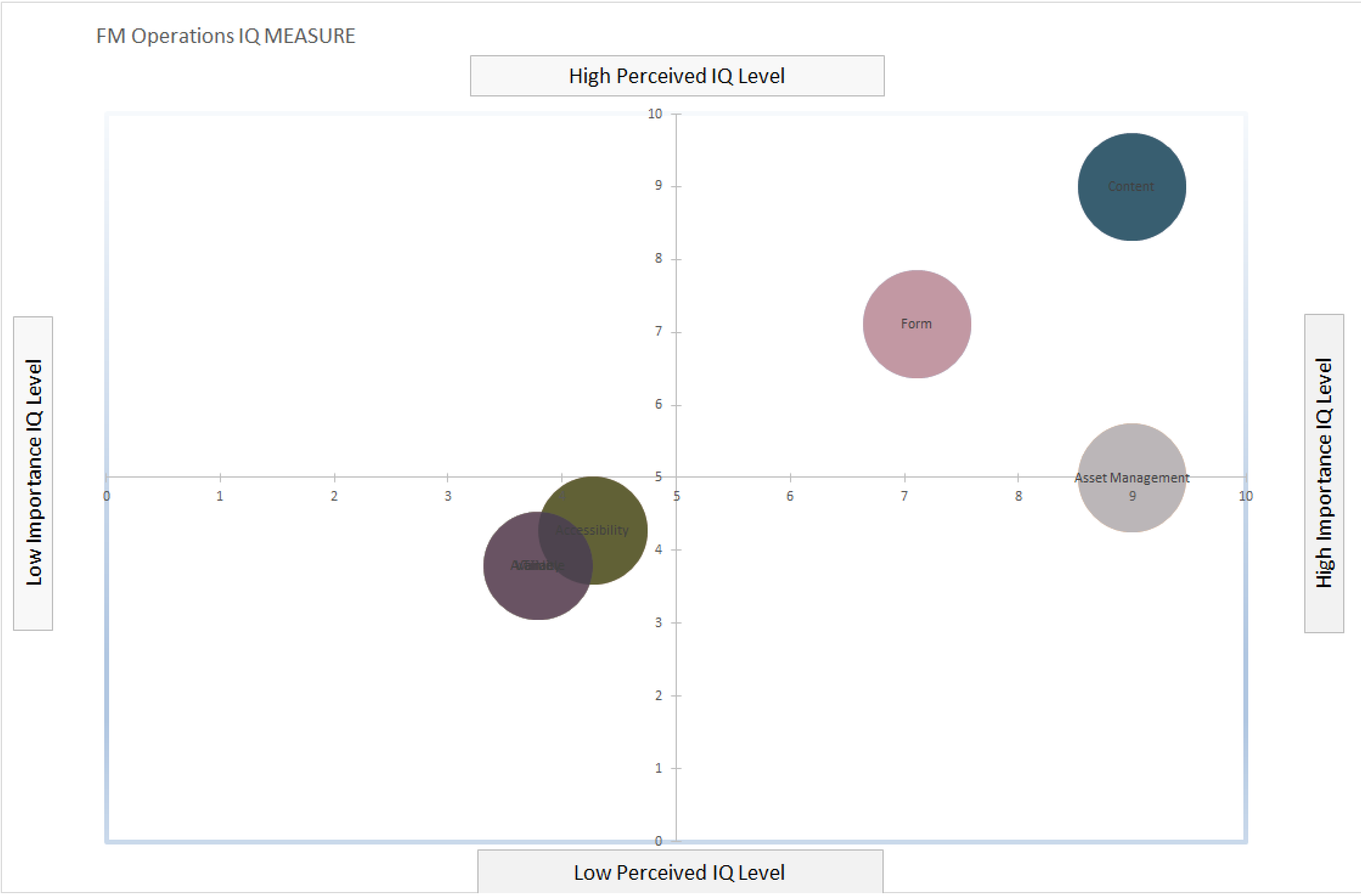
Step 2 **Enter the two labels for your Horizontal Axis**
For the left side of the map: Low Importance IQ Level
For the right side of the map: High Importance IQ Level

Step 3 **Enter the two labels for your Vertical Axis**
For the bottom of the map: Low Perceived IQ Level
For the top of the map: High Perceived IQ Level

Step 4 **Enter the Dimensions to be Mapped** — Up to a maximum of 25 items
Step 5 **IQ Dimension Cluster**
Score each dimension/item for the two attributes — Use a 1-9 scale, using the following table as a guide.
Step 6 **Change the circle sizes**

				Horizontal Attribute 1 = Low Importance IQ Level 5 = Equal mix of both 9 = High Importance IQ Level	**Vertical Attribute** 1 = Low Perceived IQ Level 5 = Equal mix of both 9 = High Perceived IQ Level	**Sizes** 1 = Small 2 = Medum 3 = Large
		Information Quality Dimensions				
IQ Dimensions	1	**Form**	**Aesthetic**	7.11	7.11	1
	2	**Visualisation**				1
	3	**Time**	**Currency**	3.79	3.79	1
	4	**Reputation**	**Dependable**			1
	5	**Validity**		3.79	3.79	1
	6	**Effectiveness**	**Operational**			1
	7	**Robustness**				1
	8	**Accessibility**	**Security**	4.27	4.27	1
	9	**Available**		3.79	3.79	1
	10	**Content**	**Usable**	9	9	1
	11	**Scope**				1
	12	**Volume**	**Volume**			1
		Organisational Dimensions				
Orgn isati onal	1	Strategic Level				
	2	Tactical Level				
	3	Operational Level				
Orgnisational Unit	1	Helpdesk/Customer Service				
	2	Maintenance				
	3	IT				
	4	Quality				
	5	Finance/Accounting				
	6	**Asset Management**		9	5	1
	7					

Step 7 **When finished entering your data above, simply copy your Perceptual Map below and paste it into your document.**


FM Operations IQ MEASURE
High Perceived IQ Level
Low Perceived IQ Level
Low Importance IQ Level
High Importance IQ Level
Content
Form
Asset Management
Accessibility
0
1
2
3
4
5
6
7
8
9
10

FRAMEWORK VALIDATION QUESTIONNAIRE

Information Quality Assessment Perceptual Map (IQAPerMap) Validation Questionnaire

This questionnaire seeks to obtain relevant and objective opinion(s) to the functionality of the framework (IQAPerMap) in assessing the quality of information in an organisation. The framework is the result of investigation based on the PhD thesis titled: "Developing a Framework to Facilitate the Assessment of Asset Management Information Quality in Facilities Management Operations". The output from the thesis is "An Information Quality Assessment Perceptual Map (IQAPerMap) Framework to Facilitate the Assessment of Information Quality".

The questionnaire is divided into three (3) main sections. The first section is the consent section that guarantees anonymity. The second section collects information about the respondent (you). This is anonymised and does not identify you through the data provided. The third section of the questionnaire presents the relevant questions for assessing the framework.

*Required

Consent

This section is aimed at obtaining your consent to participate in the study. All information you provide will be confidential and in accordance with The Data Protection Act 1998 (UK Legislation, 1998). The following will apply to data and information you provided in this study:

1. All data and information obtained from this research will comply with the Data Protection Act of 1998 (http://www.legislation.gov.uk/ukpga/1998/29/schedule/1).
2. All participant data shall be anonymised and will use higher levels of data aggregation to remove personal identifiers.
3. An assurance of confidentiality and anonymity will be guaranteed through the use of pseudonyms and appropriate secure data storage.

I have read and understood the information about the research, and I consent to participate in this study

Completing the questionnaire is voluntary, but we do hope you take part (Mark only one oval)

◉ Yes

○ No [Stop filling out this form.]

About You

4. Gender * (Mark only one oval)

○ Male

○ Female

○ Prefer Not to Say

○ Others

5. What is your primary job function?

6. What level in organisation do you belong to? * (Mark only one oval)

○ Strategic

○ Tactical

○ Operational

Validation Questions

1. Please rate the following statements based on your perception of the framework
1 = Least, 2 = Low, 3 = Moderate, 4 = Very, 5 = Extremely

(Mark only one oval per row)

Criteria	**1**	**2**	**3**	**4**	**5**
How well defined are the terms and concepts of the framework? (+)	○	○	○	○	○
How well does the framework apply in your job in assessing information quality? (+)	○	○	○	○	○
How well do you feel the framework is consistent in solving information quality problems? (+)	○	○	○	○	○
Do you feel there are too many elements in the framework? (-)	○	○	○	○	○
Can the framework be used as a tool to improve information quality issues (+)	○	○	○	○	○
Can the framework be demonstrated easily to others? (+)	○	○	○	○	○

2. Do you have any additional comment on the framework?
Continue on an extra sheet if required

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